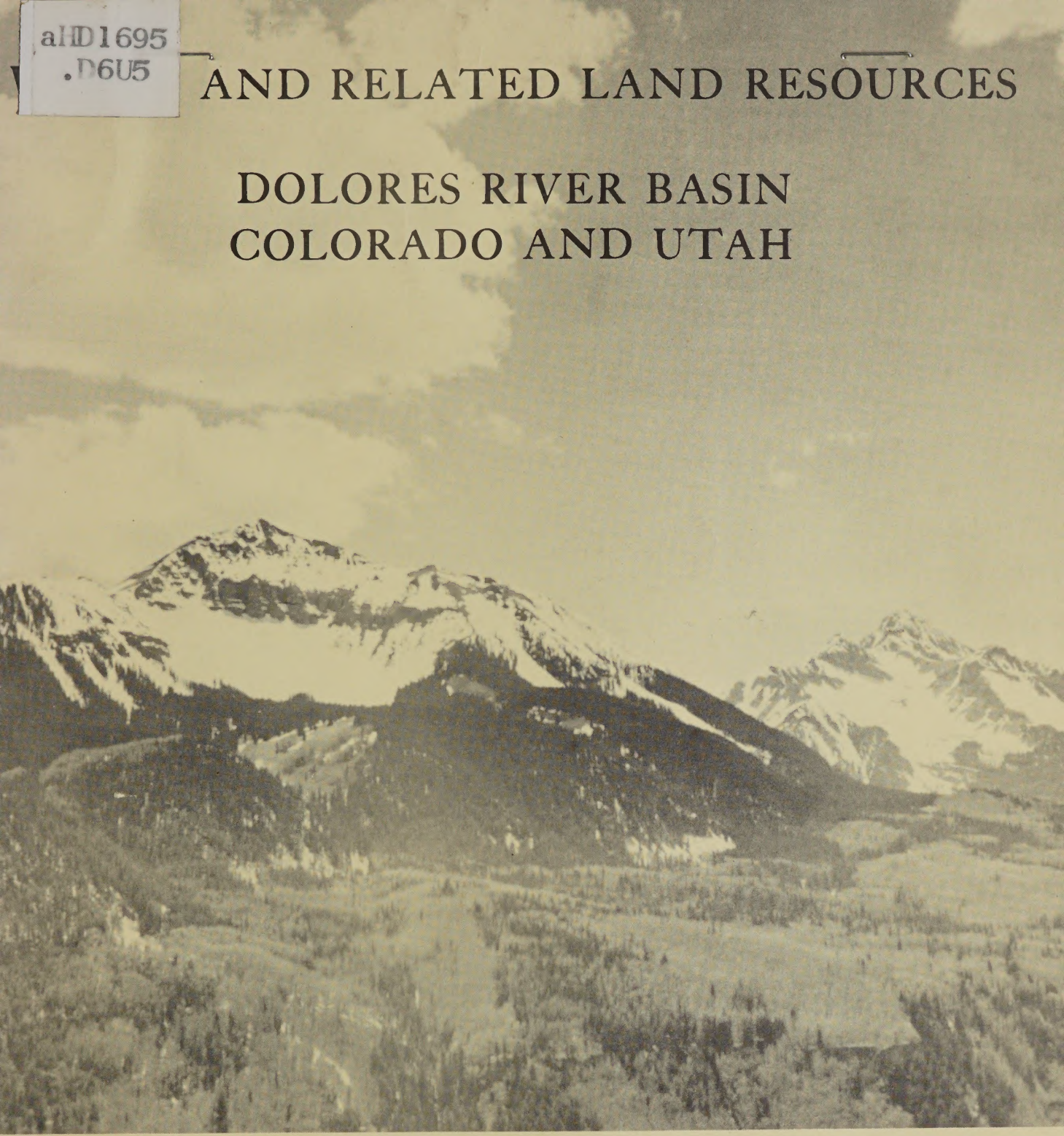
AND RELATED LAND RESOURCES

DOLORES RIVER BASIN
COLORADO AND UTAH



A Report Based on a Cooperative Study by

COLORADO WATER CONSERVATION BOARD

and

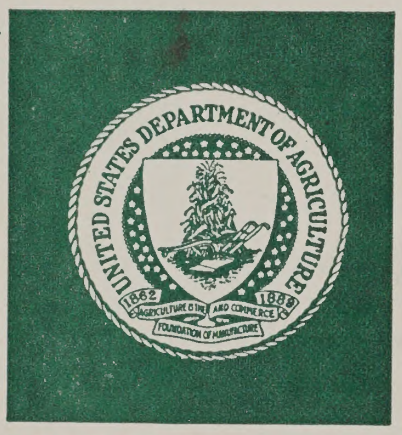
UNITED STATES DEPARTMENT OF AGRICULTURE

Prepared by

Economic Research Service - Forest Service - Soil Conservation Service

Denver, Colorado - September 1972

USDA-SCS-PORTLAND, OREGON 1972



Cover picture -- Mount Wilson, located in the Uncompahgre National Forest on the headwaters of the San Miguel and Dolores Subbasins.

WATER AND RELATED LAND RESOURCES:

DOLORES RIVER BASIN, COLORADO AND UTAH.

Agricultural Land And Water Use Near Norwood

A Report Based on a Cooperative Study by

COLORADO WATER CONSERVATION BOARD

and

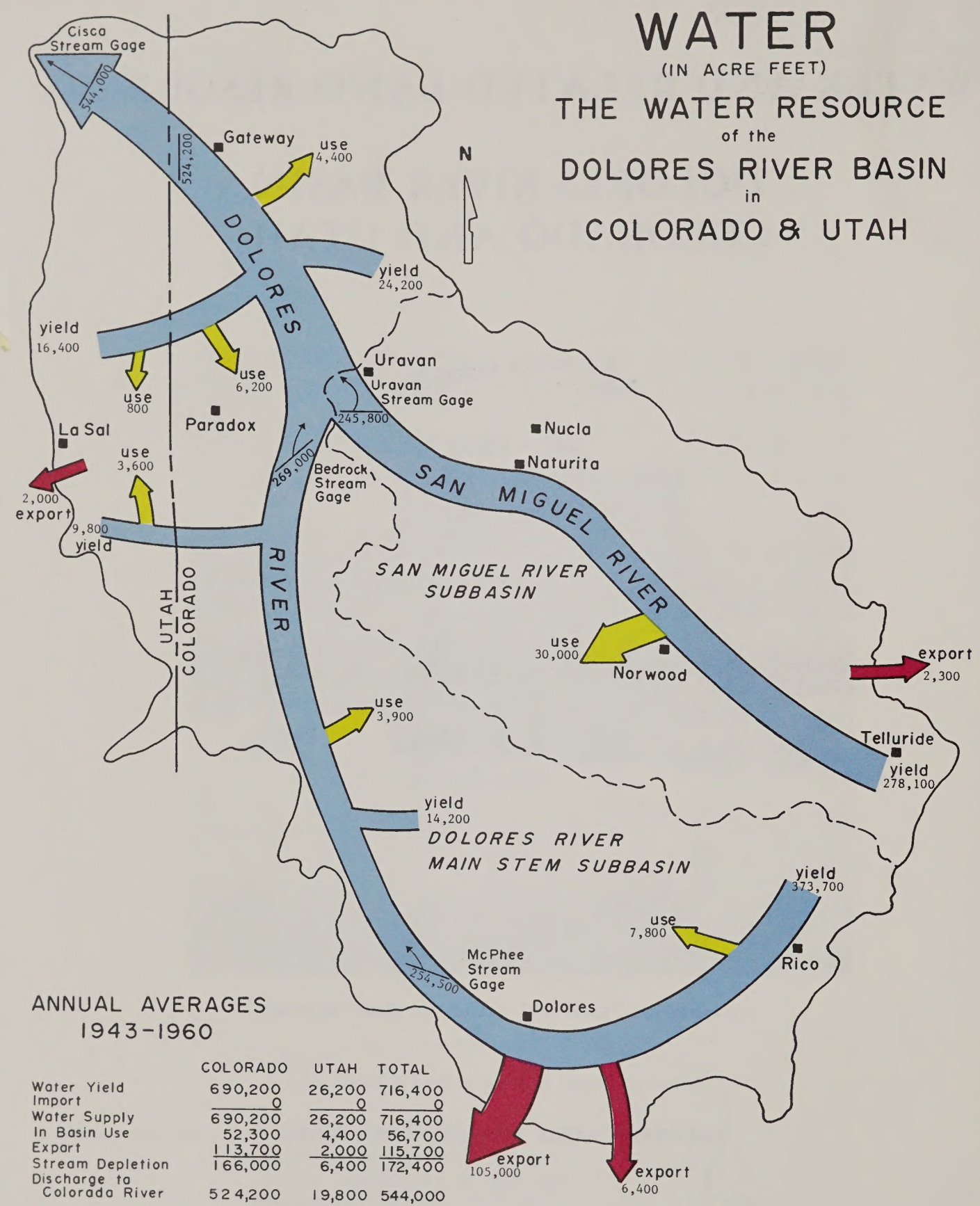
UNITED STATES DEPARTMENT OF AGRICULTURE

Prepared by

Economic Research Service - Forest Service - Soil Conservation Service

Denver, Colorado - September 1972

ALL PHOTOS U.S.D.A.

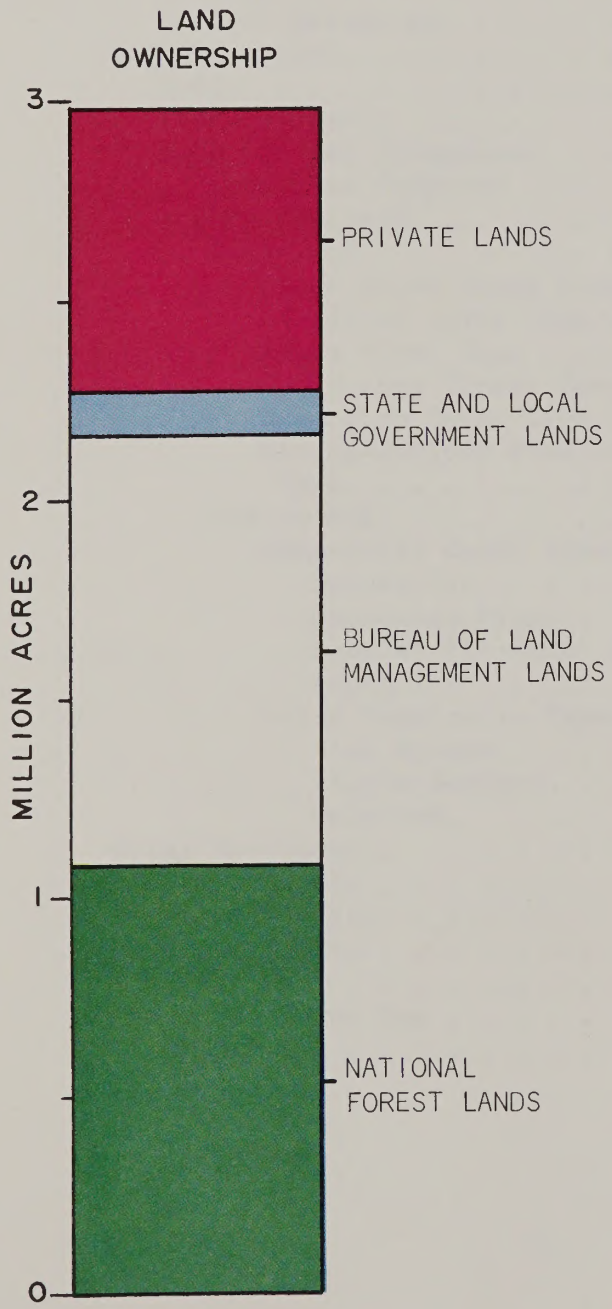


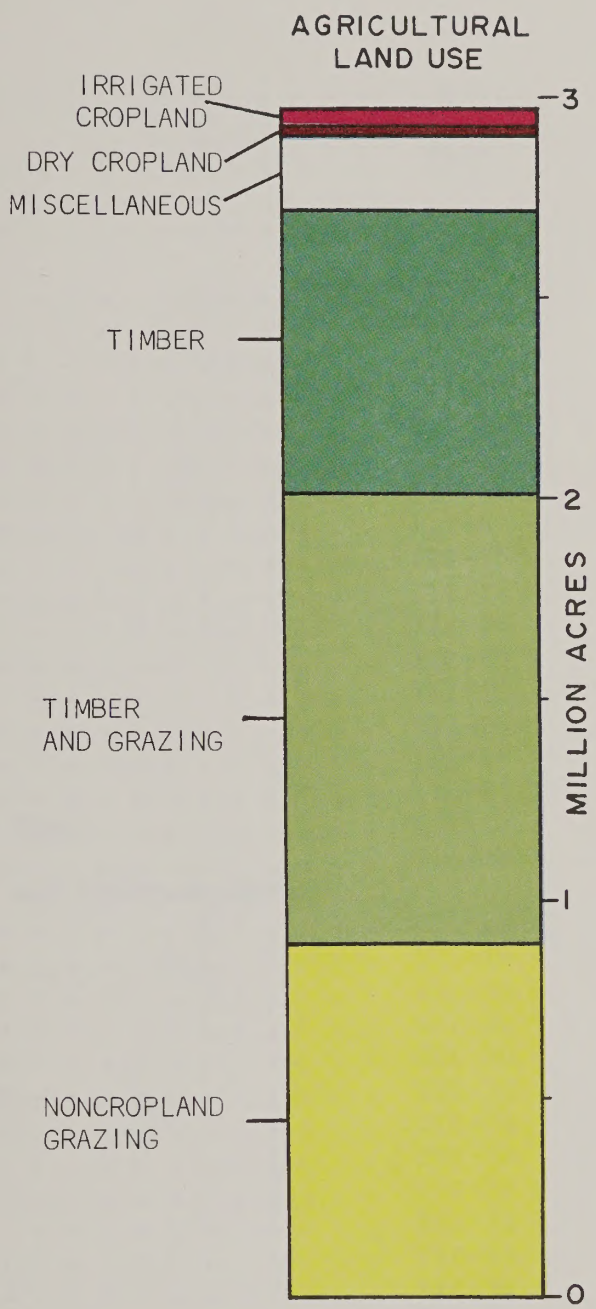
ANNUAL AVERAGES 1943-1960

	COLORADO	UTAH	TOTAL
Water Yield	690,200	26,200	716,400
Import	0	0	0
Water Supply	690,200	26,200	716,400
In Basin Use	52,300	4,400	56,700
Export	113,700	2,000	115,700
Stream Depletion	166,000	6,400	172,400
Discharge to Colorado River	524,200	19,800	544,000

LAND

COLORADO - 2,619,500 ACRES
UTAH - 353,400 ACRES
TOTAL 2,972,900





THE USE AND OWNERSHIP
OF THE
LAND RESOURCE
OF THE
DOLORES RIVER BASIN
IN
COLORADO & UTAH

FRONTISPIECE 2

CONTENTS

TABLES

ILLUSTRATIONS

MAPS

FIGURES

WATER AND RELATED LAND RESOURCES

DOLORES RIVER BASIN IN COLORADO AND UTAH

I. SUMMARY

This report presents information concerning water and related land resources of the Dolores River Basin in Colorado and Utah. It is based on a cooperative study by the Colorado Water Conservation Board and the United States Department of Agriculture. Department of Agriculture participation was authorized under the provisions of Section 6 of Public Law 566, 83d Congress, as amended and supplemented. This is one of a series of cooperative river basin surveys being conducted on the Upper Colorado River and its tributaries on the western slope of Colorado. The survey includes those portions of Colorado and Utah within the hydrologic boundaries of the Dolores River down to its confluence with the Colorado River. This study will serve as an important source of information to the Colorado Water Conservation Board in preparation of an overall water plan for Colorado.

The Dolores River is a tributary of the Colorado River. The main tributary of the Dolores River is the San Miguel River. The basin encompasses 4,645 square miles with 4,093 square miles in southwestern Colorado and 552 square miles in southeastern Utah (Drainage Map of the Dolores River Basin). This is about four percent of Colorado and less than one percent of Utah. Elevations range from 4,100 to more than 14,000 feet above sea level, while precipitation ranges from about nine inches in the desert areas to more than 50 inches along the eastern mountains. The average growing season (above 28°F.) in the irrigated areas varies from 90 to 194 days.

Water and related land resource problems include erosion damage on rangeland and dry cropland, conversion of marginal dry cropland to grassland, inefficient water management on irrigated land, sediment and salinity production from exposed shale areas, floodwater damage from snowmelt runoff, range and forest fires, and a shortage of irrigation water for late season use. Present and future physical needs for water and related land resource development includes erosion control practices, improved irrigation and drainage systems, increased efficiency in irrigation water management, proper range management, sediment control, water storage facilities for multiple use, recreation, and fish and wildlife development.

Permanent settlement of the basin began about 1877. The lower valleys were settled for ranching and farming while gold caused the development of the mining boom towns of Telluride and Placerville. Colorado became a state in 1876.

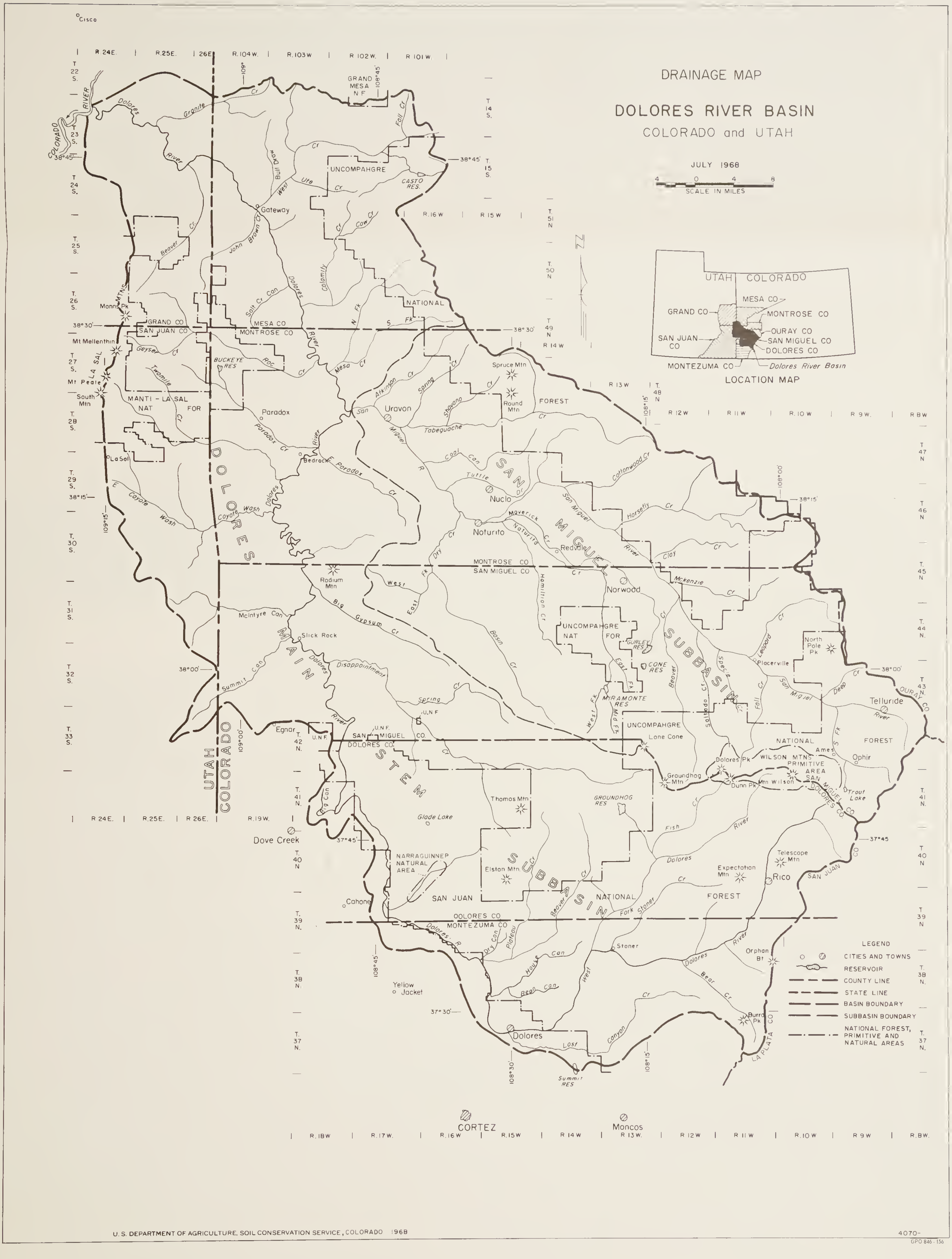
The basin is sparsely populated. The 1960 population was 10,756. Over the years there has been an erratic growth pattern in population. In 1920 the population was 8,205, but in 1930 the estimate was 5,112. Projected population is 10,800 by 1980, 12,300 by 2000, and 13,700 by 2020. Of the estimated labor force of 3,575 in 1967, agriculture employed 17.5 percent, mining 33.6 percent, forestry 2.8 percent, manufacturing 2.2 percent, construction 2.5 percent, services 25.5 percent, trade and sales 11 percent, and unemployed was 4.2 percent.

Seventy-three percent of the land in the basin is in federal ownership, 25 percent is privately owned, and approximately 2 percent is owned by state governments. Approximately two percent of the land is used for crops and pasture. The remaining 98 percent is used for grazing, timber production, watershed, recreation, mining, wildlife, and other purposes ("Land" Frontispiece 2).

Average annual undepleted water supply for the 1943-60 period was 716,400 acre-feet, average annual depletion was 172,400 acre-feet, and the average annual discharge into the Colorado River was 544,000 acre-feet ("Water" Frontispiece 1). The major use of water within the basin was for irrigation, however water transported out-of-basin represented 67.1 percent of the average annual depletions for the 1943-60 period.

The average irrigated acreage during the 1943-60 period was 47,050 acres. The 1965 irrigated acreage was 48,200. The 1980 projection for total basin irrigated acreage is 46,900 acres, and for the dates of 2000 and 2020 the acreages are 73,000. For the Colorado portion of the basin projections of irrigated acreages are 43,900 for 1980, and 70,000 for 2000 and 2020.

Livestock production dominates the agricultural industry of the basin. With the exception of a small acreage of dry beans, potatoes, small grain, and orchards, all cropland is devoted to production of feed and forage crops. The 1964 Census of Agriculture showed 33,939 cattle and calves, and 64,358 sheep and lambs in the basin. Presently, livestock use an estimated 295,800 animal unit months of grazing plus an estimated 109,100 animal unit months of winter feed produced on the irrigated and dry cropland. Total agricultural income from sale of farm products was about $5 million in 1964; of this, the sale of livestock and livestock products amounted to about $4.6 million.


DRAINAGE MAP
DOLORES RIVER BASIN
COLORADO and UTAH
JULY 1968
SCALE IN MILES
LOCATION MAP
UTAH
COLORADO
GRAND CO
MESA CO
MONTROSE CO
OURAY CO
SAN MIGUEL CO
DOLORES CO
SAN JUAN CO
MONTEZUMA CO
Dolores River Basin
LEGEND
CITIES AND TOWNS
RESERVOIR
COUNTY LINE
STATE LINE
BASIN BOUNDARY
SUBBASIN BOUNDARY
NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS
DOLORES
MAIN STEM
SAN MIGUEL SUBBASIN
SUBBASIN
Gateway
Uravon
Paradox
Bedrock
Nucla
Naturita
Redvale
Norwood
Slick Rock
Egnar
Dove Creek
Cahone
Yellow Jacket
Dolores
CORTEZ
Moncos
Stoner
Rico
Telluride
Ophir
Ames
Placerville
La Sal
Cisco
UNCOMPAHGRE NATIONAL FOREST
MANTI - LA SAL NAT FOR
SAN JUAN NATIONAL FOREST
WILSON MTNS PRIMITIVE AREA
NARRAGUINNEP NATURAL AREA
GRAND MESA N.F.
CASTO RES.
BUCKEYE RES
GURLEY RES
CONE RES
MIRAMONTE RES
GROUNDHOG RES
SUMMIT RES
Spruce Mtn
Round Mtn
Radium Mtn
Thomas Mtn
Elston Mtn
Lone Cone
Groundhog Mtn
Dolores Pk
Dunn Pk
Mtn Wilson
North Pole Pk
Telescope Mtn
Expectation Mtn
Orphan Bt
Burro Pk
Monns Pk
Mt Mellenthin
Mt Peale
South Mtn
LA SAL MTNS
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968
4070-
GPO 846-156

The basin is a recreation area of regional significance. Big game hunting, cold water fishing, and camping are activities in demand. Skiing is an emerging activity and has good potential for development, provided that limiting factors such as inadequate roads, transportation, accommodations, and facilities can be rectified.

Many studies concerning proposed water and related land resource developments have been made by state, federal, local agencies, and private enterprise. Those that appear to have the most potential have been included in this report's projection of land and water use by 1980, 2000, and 2020. Constraints imposed by ownership, legal and institutional factors, location, and water supplies will determine availability of land for future development.

With project developments, estimated total water depletions will be 343,100 acre-feet by 1980, 393,300 acre-feet by 2000, and 433,100 acre-feet by 2020. Water resources are adequate to meet water requirements of proposed resource developments outlined in this report, including potential municipal and industrial requirements. Export water transported out-of-basin accounts for 273,900, 273,900 and 289,900 acre-feet of these depletions for 1980, 2000, and 2020.

With development of the basin, the conservation of land and water resources will become increasingly important. The multiple purpose aspects of Public Law 566 projects offer effective solutions to many of the land and water problems. Much of the development needed by 1980 is included in the USDA early action program. Watershed investigations have been made on five potential watershed projects - Paradox, Gurley, Dolores, Naturita and Tabeguache - and the conclusions are that four have potential for development by 1980. There are other project opportunities available for USDA assisted development. The National Forest Development and Multiple Use Programs have extensive work schedules for the next 10-15 years on the Grand Mesa-Uncompahgre, Manti-La Sal and San Juan National Forests. The U. S. Forest Service is cooperating with the Colorado and Utah State Forest Services on similar programs on state and private forest lands. The Farmers Home Administration is included in the early action program with two projects - an insured loan to the town of Naturita to improve and expand its domestic water system, and loans to the Sky Hi Ski Club to improve and develop the ski course at Stoner. There are many smaller land and water development opportunities. These are generally of a type or size that could be assisted through other USDA programs. Assistance could include cost-sharing through Agricultural Stabilization and Conservation Service (ASCS) pooling agreements and Soil Conservation Service (SCS) technical help to group enterprises or individuals.

There are two authorized Bureau of Reclamation projects -- the San Miguel and the Dolores. All project features of the San Miguel Project are in the Dolores Basin. The diversion and storage sites of the Dolores

Project are on the Dolores River,and water from this project will be exported for use in the San Juan Basin. The two projects will add 12,000 surface acres of water and area for recreational opportunities in addition to supplying water for irrigation. Development of 26,000 acres of new irrigated land, plus 12,000 acres of land that receive supplemental water from the San Miguel Project, will require all phases of agricultural preparation and management prior to successful irrigated farming. Other benefits include water for municipal and industrial purposes as well as fish and wildlife use.

Program coordination is necessary to assure that proposed project and resource development opportunities complement each other and provide for coordinated development of resources of the basin. Program coordination can be accomplished through USDA Committees for Rural Development and the Four Corners Regional Commission. Potential project opportunities that could be eligible for supplemental grants include the Dolores, Gurley, Tabeguache, and West Paradox Watershed Projects as well as hospital, transportation facilities, and municipal sewer and water needs.

II. INTRODUCTION

This is one of a series of cooperative river basin surveys being conducted on the western slope of Colorado by the U. S. Department of Agriculture and the Colorado Water Conservation Board. Utah data was developed through cooperation of various federal, state, and local agencies with the USDA Field Advisory Committee, Colorado Rivers. Survey work by the United States Department of Agriculture was carried out by technicians of the Soil Conservation Service, Forest Service, and Economic Research Service under the direction of a USDA Field Advisory Committee, Colorado Basins, composed of representatives of these agencies.

United States Department of Agriculture participation was authorized under provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566), 83d Congress, as amended and supplemented. This authorizes the Department to cooperate with other federal, state, and local agencies in making investigations and surveys of watersheds of rivers as a basis for development of coordinated programs.

The principal objective of this study was the collection and development of information on water and related land resource use and management with particular regard to multiple use, to provide a basis for coordinating USDA programs of watershed protection, flood prevention, land and water management, fish and wildlife development, recreational development, municipal and industrial water development with the related activities of local, state, and other federal agencies. An additional objective is the projection of water and related land resource developments and subsequent impacts. Information is also presented which will provide a basis for development of projects under the Watershed Protection and Flood Prevention Act, Public Law 566, as amended. This study will serve as an important source of information to the Colorado Water Conservation Board in the preparation of an overall water plan for Colorado. Previous studies resulted in reports on Water and Related Land Resources of the Gunnison River Basin (1962), the Colorado River Basin in Colorado (1965), the White River Basin in Colorado (1966), and the Yampa River Basin in Colorado and Wyoming (1969). A similar study has been initiated for the San Juan River Basin.

This study utilized applicable data from previous investigations wherever possible. The report is developed from field surveys and analysis of material collected from many sources. It is presented in the form of an inventory or information document rather than as an authorizing report. The data provided is being used as a basic source of information for use in the Upper Colorado Region Comprehensive Framework Study now in progress.

For these currently scheduled river basin surveys, hydrologic and water supply studies are being standardized to include 1943-60 as a base study period. These years have been selected because of the greater availability of streamflow data and other necessary records, and because they include periods of both above and below longtime average streamflows. They are reasonably representative of conditions existing during recent time periods and may be compared with other base periods through statistical or analytical procedures. Other data, where necessary and possible, were developed for the same time period. The year 1965 was generally used in the report as the present time period for data collection -- 1980, 2000, and 2020 being used for data projection periods. These four dates - 1965, 1980, 2000, and 2020 - are in agreement with other river basin studies being coordinated by the Water Resources Council. Data from the 1967 Conservation Needs Inventory were used extensively in this report.

In addition to the U.S. Department of Agriculture and the Colorado Water Conservation Board, several other federal and state agencies have provided data and assistance for this report. Contributors were the U. S. Bureau of Reclamation, U. S. Bureau of Land Management, Colorado State Soil Conservation Board, Colorado River Water Conservation District, Colorado State Forest Service, Upper Colorado River Commission, U. S. Bureau of Census, U. S. Statistical Reporting Service, U. S. Geological Survey, U. S. National Weather Service, National Park Service, Utah State Forest Service, Colorado Division of Public Works, Colorado Division of Commerce and Development, Colorado Department of Agriculture, Colorado Division of Game, Fish and Parks*, the Glade Park, San Miguel Basin, Dove Creek, and Dolores Soil Conservation Districts in Colorado, the San Juan County Soil Conservation District in Utah, and the water user's associations and conservancy districts within the basin.

---

* Reorganized as Colorado Division of Parks and Outdoor Recreation and Colorado Division of Wildlife.

III. NATURAL RESOURCES OF THE BASIN

Location and Size

The Dolores River Basin is located in southwestern Colorado and east-central Utah. Its boundary encompasses an area of approximately 4,645 square miles, with 4,093 in Colorado and 552 in Utah, in the Upper Colorado River Region 1/. The basin area is slightly over 4 percent of the total region area. The basin drains parts of Mesa, Montrose, San Miguel, Montezume, Ouray, and Dolores Counties, Colorado, and Grand and San Juan Counties, Utah. It is approximately 100 miles long from north to south and varies from 30 to 70 miles in width. It is bounded on the south and wast by the San Juan Mountains and the Uncompahgre Plateau. The La Sal Mountains in Utah form part of the western boundary. The Dolores River and its tributaries drain almost four percent of Colorado and less than one percent of Utah.

Climate

The climate of the basin is typical of most of Colorado's western slope basins with wide extremes resulting from variations in topographic features. The alpine zone exists in mountain areas above 11,000 feet in elevation and transcends to arid desert climate in lower basins of 5,000 to 6,000 foot elevation. Mount Wilson, the highest point in the Colorado portion of the basin, reaches 14,246 feet, and Mount Peale (12,721 feet) is the highest point in the Utah portion.

Precipitation averages 17 inches or 4.2 million acre-feet annually in the basin, varying from 7 to 9 inches in the desert valleys to 45 inches in the alpine area of the San Miguel Mountains. In Colorado the average precipitation ranges from less than 10 inches near the Colorado-Utah state line to over 50 inches along the southeastern boundary. The La Sal Mountains in Utah receive over 30 inches, and amounts decrease to about 9 inches at the Dolores-Colorado River confluence near Cisco, Utah. Total annual snowfall varies from 254 inches at Trout Lake, Colorado, to 40 inches at La Sal, Utah, and 22 inches at Paradox. The Annual Average Precipitation Map, following pg.III-2 indicates, with isohyetal lines, the precipitation pattern in the basin. Seasonal distribution of precipitation is fairly uniform. The Norwood area receives about 35 percent of its annual precipitation as snow during the December-April period while

---

1/ Upper Colorado Region Comprehensive Framework Study, June 1971.

the Telluride area receives about 40 percent during the same period. Norwood receives about 55 percent of its precipitation during the growing season while Telluride receives about 35 percent. The winter snowpack provides a form of reservoir that is the principal source of streamflow. Cloudburst storms of high intensity and short duration occur over localized areas and result from summer convective conditions. These storms are typical of the lower elevations and occasionally cause floods that are major carriers of the basin's suspended sediment yield.

The mean annual temperatures range from 54°F. at Gateway to 46°F. at La Sal, Utah, and 39°F. at Rico. January is generally the coldest month, and July is distinctly the warmest. The difference in mean temperature between the coldest and warmest month is about 40° at high mountain stations and 50° at lower valley stations. Temperatures vary between extremes of 106°F. to -28°F. at Gateway, 101°F. to -27°F. at La Sal, Utah, and 100°F. to -36°F. at Rico.

The length of the growing season varies throughout the basin. Gateway has an average annual growing season (28°F. freeze threshold and above) of 194 days, La Sal, Utah averages 153 days, and Rico averages 90 days. Most of the irrigated land in the basin lies between Norwood and Uravan with an average annual growing season at Norwood of 133 days.

Net annual evaporation losses from ponds and reservoirs varies from 50 inches in the desert valleys to 26 inches in the upper elevations.

Physiography and Geology

Physiography

Most of the Dolores River Basin lies within the eastern part of the Canyon Lands section of the Colorado Plateaus physiographic province, an area of plateaus underlain by relatively horizontal rock layers and dissected by deep canyons. Narrow areas along the southeastern margins of the basin are occupied by the San Juan Mountains portion of the Southern Rocky Mountains physiographic province. Elevations vary from 4,095 feet where the Dolores River flows into the Colorado River to 14,246 feet on Mount Wilson in the southeastern part of the basin.

The San Juan Mountains, which lie along the southeastern edge of the basin, are a well-defined area of rugged mountains rising abruptly from the mesa surfaces of the adjoining Colorado Plateaus province and containing several peaks over 13,000 feet in height. They consist largely of volcanic rocks in more or less horizontal layers, overlying older sedimentary rocks. Most of the area has been glaciated, and such typical glacial features as knife-edge ridges, cirques, and rock streams are common.

AVERAGE ANNUAL PRECIPITATION

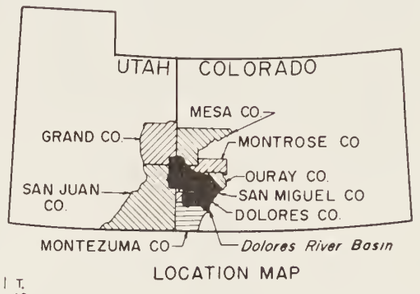
DOLORES RIVER BASIN

COLORADO and UTAH

JULY 1968

4 0 4 8

SCALE IN MILES



LOCATION MAP

1943-60 average annual precipitation, in inches

- 7 to 9 inches
- 9 to 12 inches
- 12 to 16 inches
- 16 to 20 inches
- 20 to 25 inches
- 25 to 30 inches
- 30 to 40 inches
- 40 to 50 inches
- (15.0) Station Precipitation
- [15.0] Snow Course Stations (Water Content)

LEGEND

- CITIES AND TOWNS
- RESERVOIR
- COUNTY LINE
- STATE LINE
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

4070-7

GPO 851-260

Canyon lands of the San Miguel River

South of Telluride between the headwaters of the Dolores and San Miguel Rivers, a west-ward projection of the San Juan Mountains has been isolated by erosion from the main mountain mass and is known as the San Miguel Mountains, of which Mount Wilson is the most prominent peak.

South of the San Miguel Mountains are two smaller ranges, the Rico Mountains and the La Plata Mountains. Both are domed uplifts of sedimentary rocks intruded by igneous rocks. Both groups have many peaks more than 12,000 feet high.

The remainder of the Dolores River Basin, lying within the Canyon Lands section, is an area of diverse topography containing narrow mesas, broad plateaus, wide structural valleys bordered by steep cliffs, high dome mountains, and deep, narrow, steep-sided canyons. The most prominent general features of this area are the La Sal Mountains on the northwest side of the basin, the Uncompahgre Plateau on the northeast side of the basin, and the narrow mesas, broad valleys, steep cliffs, and deep canyons of the salt anticline area in the central portion of the basin.

The La Sal Mountains rise 6,000 to 7,000 feet above the surrounding plateau level and consist of three groups of peaks, many of which rise to elevations of more than 12,000 feet. Mount Peale, in the central group, is the highest with an elevation of 12,721 feet. The La Sal Mountains consist of domed uplifts formed by the intrusion of three igneous stocks. The higher areas in these mountains have been glaciated and contain numerous small cirques and other glacial features.

The Uncompahgre Plateau is a broad structural uplift which trends northwesterly for about 90 miles along the northeastern side of the basin. Maximum elevation on the Uncompahgre Plateau is 8,500 to 9,000 feet. The summit of the plateau is relatively flat, but much of the west side consists of deep canyons, sharp cliffs, and steeply sloping mesas.

The extensive salt anticline area which occupies most of the central portion of the basin is characterized by a series of anticlines and intervening synclines with northwest-southeast trends. These structures are the result of salt flowage in the underlying sedimentary beds. Well-developed anticlines having intrusive cores of salt and gypsum underlie Fisher, Sinbad, Paradox, Gypsum, and Lisbon Valleys in the western part of the basin. Topographically the axis of these anticlines are marked by elliptical valleys which have been formed by the removal of resistant beds above and exposure of the weaker beds beneath. All of these anticlinal valleys are characterized by steep inward-facing valley walls of resistant strata and relatively flat and featureless valley floors.

In two areas, Dry Creek Basin and Disappointment Valley, synclinal valleys with gently rolling slopes have developed in relatively soft shales. In many places through the salt anticline area, steep-sided canyons 1,000 to 1,500 feet deep have been cut into the relatively flat-lying sedimentary strata by the Dolores and San Miguel Rivers and their major tributaries.

Geology

Rocks ranging in age from Precambrian through Quaternary are exposed in the Dolores River Basin (Generalized Bedrock Geology Map following page III-4). They consist of crystalline rocks of Precambrian age, volcanic rocks of Tertiary age, and a thick sequence of sedimentary rocks of Paleozoic and Mesozoic age. Areal distribution of these rocks is mainly controlled by the extensive uplifts represented by the Uncompahgre Plateau and Rico Mountains and the more localized uplifts of the salt anticline area. The older rocks are generally exposed in these areas, while the younger rocks are generally exposed in the intervening synclinal areas.

The oldest rocks are the Precambrian crystalline rocks exposed in the canyons along the west side of the Uncompahgre Plateau. These consist mainly of a gray medium-grained gneissic granite which is intruded by a pink coarse-grained granite. Smaller areas of schist and gneiss occur in a few places.

Paleozoic rocks of Pennsylvanian and Permian age crop out mainly in the anticlines of Fisher, Sinbad, Paradox, Gypsum, and Lisbon Valleys, and in the Rico Mountains and along the northwest edge of the Uncompahgre

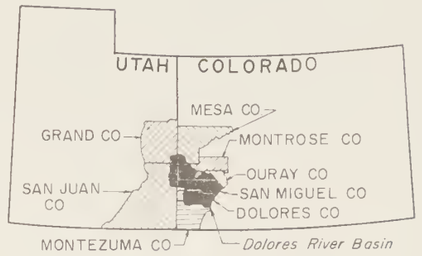
GENERALIZED
BEDROCK GEOLOGY MAP

DOLORES RIVER BASIN

COLORADO and UTAH

JULY 1968

4 0 4 8
SCALE IN MILES



LOCATION MAP

TERTIARY
Tv Tertiary Volcanics
MESOZOIC
Kmv Mesaverde Group
Km Moncos Shale
KJ Tr Lower Cretoecous, Jurassic, Triassic
PALEOZOIC
Pz
PRECAMBRAIN
P€
Metal Mine
Coal Field
Oil Field

LEGEND
CITIES AND TOWNS
RESERVOIR
COUNTY LINE
STATE LINE
BASIN BOUNDARY
SUBBASIN BOUNDARY
NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

GPO 844-509 4070-1

Plateau uplift. These rocks include gray shale and limestone with salt and gypsum beds overlain by red arkosic sandstones and conglomerates with beds of red mudstone. The formations represented are the Hermosa, Rico, and Cutler.

Mesozoic rocks crop out in all parts of the basin and consist of several thousand feet of alternating beds of sandstones, siltstones, and shales with the sandstones predominating. This sequence of rocks includes: the Moenkopi Formation, Chinle Formation, Wingate Sandstone, Kayenta Formation, and Dolores Formation of Triassic age; the Navajo Sandstone of Triassic and Jurassic age; the Entrada Sandstone, Summerville Formation, Wanakah Formation, and Morrison Formation of Jurassic age; the Burro Canyon Formation and Dakota Sandstone of Early Cretaceous age; and the Mancos Shale and Mesaverde Group of Late Cretaceous age.

Volcanic rocks of Middle and Late Tertiary age occur in the San Juan Mountains area of the basin. They consist mainly of tuffaceous sandstone and tuff breccia of the San Juan Formation and the Silverton Volcanic Group. In most places they are underlain by the Telluride Conglomerate of Early Tertiary age. Igneous intrusive rocks of Tertiary age consisting of dikes, sills, stocks, and laccolithic bodies occur in the La Sal Mountains and La Plata Mountains as well as in the San Juan Mountains.

Quaternary deposits ranging in age from Pleistocene to Recent are widespread in the Dolores River Basin. Glacial moraines representing several intervals of glaciation are present along most of the major valleys in the San Juan Mountains, La Sal Mountains, and La Plata Mountains. Landslide deposits, rock glaciers, and talus deposits are also common in these mountain areas. Several levels of mesa and terrace surfaces underlain by sandy and gravelly alluvial deposits occur along the larger stream valleys. Deposits of wind-blown silt and sand occur on the more extensive mesa surfaces and in the larger valleys. Recent alluvium occurs in the floodplains of most smaller tributaries as well as along the larger streams.

Mineral Resources

Uranium, vanadium, zinc, lead, copper, silver, gold, coal, petroleum, sand and gravel, and stone are the most important minerals currently being produced in the basin. Uranium and vanadium ores account for more than four-fifths of the total value of mineral production. Uranium-vanadium ore deposits occur mainly in the Salt Wash Member of the Morrison Formation on the flanks of the salt anticlines in the eastern parts of Grand and San Juan Counties, Utah, and in the western parts of Mesa, Montrose, and San Miguel Counties, Colorado.

Production of other metallic minerals including zinc, lead, copper, silver, and gold has been almost entirely from the San Juan Mountain area in the eastern parts of San Miguel and Dolores Counties, Colorado. The most important producing areas are those in the vicinity of Telluride, Pandora, and Ophir in San Miguel County and near Rico in Dolores County.

Sand and gravel and stone produced at pits and quarries in various parts of Mesa, Montrose, San Miguel, and Dolores Counties are used mainly for construction purposes such as aggregate for concrete, mortar, and asphalt and as road base.

The coal resources of the basin are located mainly in the Nucla-Naturita coal field in Montrose County, Colorado. The coal occurs in the Dakota Formation. A total of about 114 million tons of bituminous coal is estimated by the U. S. Geological Survey to have been originally present in the 15 square miles of this field.

Oil production within the basin has been limited to relatively small amounts obtained from the Southeast Lisbon field in San Miguel County, Colorado, and from part of the Northwest Lisbon field in San Juan County, Utah. The potential for discovery of additional fields remains for the entire salt anticline area, and sporadic test drilling is continuing throughout the area.

Land Resources

Soils

A general soil survey is useful in that soils with similar characteristics and suitability can be located and related to different parts of the basin. The broad characteristics and relationships can be used in a general way to interpret the potential of soils for agricultural, recreational, commercial, and industrial uses. Problems of erosion, sediment yield, present land use, and future development are interrelated with soils and their distribution.

The General Soil Map following pg. III-6 was prepared by delineating eight mapping units that differ from each other in the kinds of soil that are present. The soils in each mapping unit are associated and form patterns that are repeated from place to place. They were defined and described according to requirements imposed by the map scale and criteria from the Comprehensive System of Soil Classification, adopted in January 1965. The composition of the units along with related characteristics

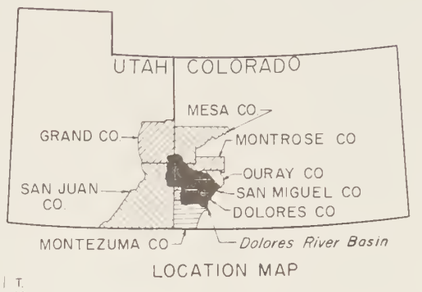
GENERAL SOIL MAP

DOLORES RIVER BASIN

COLORADO and UTAH

JULY 1968

4 0 4 8
SCALE IN MILES



LOCATION MAP

SOIL MAPPING UNITS

1 Light-colored soils of the deserts.
2 Reddish-brown soils of the dry valleys.
Rock outcrop and very shallow soils of the canyons.
4 Moderately dark-colored deep soils of the mesas and valleys.
5 Dark-colored soils of the cold mountain slopes
6 Light-colored soils of the cold mountain slopes.
7 Dark-colored soils with light colored subsurface horizons of the cold mountain slopes.
8 Dark-colored soils and rock outcrop of the alpine region.

LEGEND

CITIES AND TOWNS
RESERVOIR
COUNTY LINE
STATE LINE
BASIN BOUNDARY
SUBBASIN BOUNDARY
NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS

U S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

4070-2

GPO 844-722

and interpretative information are shown in Table 1. Readers interested in more detailed information about the classification system should consult technical publications. 2,3/

Acreage distribution of mapping units and percent that each occupies is given in Table 2. Composition and related characteristics of each soil mapping unit are given in the following brief narrative descriptions.

Soil Mapping Unit 1: Light-colored soils of the deserts
This unit is in Disappointment Valley, mostly in San Miguel County, but a small part extends into Dolores County. This unit is one of the least extensive in the basin. Water intake is slow and runoff is rapid. Erosion is moderate to severe and sediment yield is in the range of 1.0-3.0 acre-feet per square mile per year.

The landscape is characterized by a wide oblong valley with rolling shale hills on the north and east and steep barren shale hills to the southeast. There are many intermittent drainageways into Disappointment Creek. Most of these drainageways are eroded to depths of 10 to 20 feet and widths of 10 to 50 feet. A sparse cover of shadscale is present with some sagebrush, rabbitbrush, and greasewood along the drainageways. On the upper reaches of the valley there are a few pinyon-juniper.

There are three major groups of soils in this unit. Shallow soils derived from Mancos Shale make up about 50 percent of the unit. They have light-colored, calcareous, surface layers, are low in organic matter and have fine and moderately fine textures. These soils are on rolling hills, mainly on the north and east side of Disappointment Creek. Another 35 percent of the unit consists of deep and moderately deep fine textured alluvial soils. These soils are along Disappointment Creek. They usually have light-colored surface layers although in the upper reaches of the valley they become darker. The soils are moderately saline-alkali and have a slow permeability rate. The remaining 15 percent of the unit consists of reddish-brown, moderately deep soils on small terraces, mainly on the south and west side of Disappointment Creek. Surface layers are light-colored and the permeability rate is moderate.

2/ Soil Survey Staff, SCS, USDA
"Soil Classification, a Comprehensive System 7th Approximation," 1960 and as amended through October 1966.

3/ Aandahl, Andrew R.
"The First Comprehensive Soil Classification System" Journal of Soil and Water Conservation 20:243-246, 1965.

Table 1.--Composition and characteristics of soil mapping units of the Dolores River Basin in Colorado and Utah

Map symbol	Composition: Percent	Composition: 1966 Great Group, Subgroup or Land Type	Percent of basin	Dominant elevation (feet)	Mean annual precipitation (inches)	Mean annual temperature (F°)	Frost free period (days)	Dominant parent materials	Dominant slope (percent)	Estimated sediment yield (Ac. ft./ sq. mi./ yr.)	Erosion problems	Major land uses	Irrigated cropland (acres)	Dry cropland (acres)
1	38	Torriorthents (shallow)	2.0	5,000-6,000	7-12	45-50	115-145	Shale and alluvium	1-25	1.0-3.0	Moderate to severe sheet and gully erosion	Winter range	700	None
	25	Camborthids												
	25	Torrifluvents												
	5	Badlands												
	5	Haplargids												
	2	Natrargids												
2	35	Torriorthents	4.5	5,000-7,000	7-12	45-50	115-145	Sandstone and shale alluvium	2-15	0.5-3.0	Moderate to severe sheet and gully erosion	Winter range, irrigated cropland	4,700	100
	30	Torrifluvents												
	20	Camborthids												
	10	Haplargids												
	5	Natrargids												
3	45	Rock and shale outcrops	32.5	4,200-9,000	7-18	42-52	100-160	Sandstone with some shale and alluvium	25-100	<0.2-1.0	Moderate sheet erosion, many gullies, damage severe locally	Range, wildlife	3,800	None
	25	Haplustolls (shallow over sandstone and shale)												
	20	Torriorthents (shallow over sandstone and shale)												
	4	Lithic Argiustolls												
	4	Boralfs and Cryoborolls												
	2	Torrifluvents												
4	45	Argiustolls and Haplustolls	10.0	5,700-7,200	12-15	45-49	110-125	Eolian, residual and alluvium from sandstone and shale	3-20	0.2-1.0	Moderate sheet and gully erosion	Range, dry land and irrigated cropland, wildlife	25,300	12,300
	40	Haplargids and Camborthids												
	10	Torriorthents (shallow over sandstone and shale)												
	5	Torrifluvents and Natrargids												
5	50	Argiborolls, Haploborolls	22.0	6,800-9,500	15-20	40-45	75-115	Sandstone shale and outwash	3-35	0.2-1.0	Moderate sheet erosion, gullies locally	Range, wildlife, irrigated cropland	6,900	4,000
	15	Boralfic Cryoborolls												
	15	Haplustolls (shallow over sandstone and shale)												
	10	Argiustolls, Haplustolls												
	5	Haplustolls, Haplaquolls												
	5	Rock and shale outcrop												
6	58	Cryoboralfs	4.5	8,500-11,500	20-40	25-42	Usually frost every month	Mixed sandstone shale volcanics rocks	10-60	< 0.2	Geological, slight gully erosion	Timber, range, wildlife, watershed	None	None
	15	Boralfic Cryoborolls												
	15	Lithic Cryoborolls												
	5	Argiborolls												
	5	Rock outcrop												
	2	Cryaquolls												
7	54	Boralfic Cryoborolls and Cryoborolls	22.5	7,400-11,000	20-40	25-40	Usually frost every month	Mixed shale sandstone outwash, and alluvium	15-65	<0.2	Geological, slight sheet and gully erosion	Range, timber, recreation, watershed	6,800	None
	15	Cryoboralfs												
	15	Lithic Cryoborolls												
	10	Argiborolls												
	3	Haplaquolls and Cryaquolls												
	3	Rock outcrop												
8	50	Rock outcrop and talus	2.0	10,500-14,250	25-45	25-30	Usually frost every month	Granite, sedimentary talus	10-80	<0.2	Geological	Wildlife, range, watershed	None	None
	25	Lithic Cryorthents												
	20	Cryorthods and Cryumbrepts												
	5	Cryaquods and Cryaquepts												

Source: Developed by USDA Field Party

Table 2.--Acreage of soil mapping units and percent of area covered, Dolores River Basin in Colorado and Utah, 1965

Map symbol	Colorado		Utah		Dolores River Basin	
	Acres	Percent	Acres	Percent	Acres	Percent
1	59,000	2.0	-	-	59,000	2.0
2	121,000	4.5	12,000	3.5	133,000	4.5
3	828,000	31.5	146,000	41.5	974,000	32.5
4	252,000	10.0	37,000	10.5	294,000	10.0
5	511,000	19.5	144,000	40.5	650,000	22.0
6	129,000	5.0	-	-	129,000	4.5
7	663,000	25.5	-	-	663,000	22.5
8	57,000	2.0	14,000	4.0	71,000	2.0
Total	2,620,000	100.0	353,000	100.0	2,973,000	100.0

Source: Developed by USDA Field Party

Soil Mapping Unit 2: Reddish-brown soils of the dry valleys
This mapping unit is in Sinbad, Paradox, Lisbon, and Big Gypsum Valleys, and Dry Creek Basin. It is not extensive but contains soils used for irrigation and those suitable for potential irrigation.

Soil mapping unit 2 in West Paradox Valley,
bordered by unit 3 in background

The landscape consists of long, narrow, gently sloping valleys that are surrounded by steep slopes and cliffs. Each valley has a main intermittent drainageway with numerous gullied tributaries. Dry Creek Basin is a wide circular valley surrounded by rolling hills. All drainageways are eroded to depths of 10 to 30 feet and widths of 10 to 50 feet. Cover is dominately sagebrush with rabbitbrush, shadscale, greasewood, and grass.

This unit is composed of about 75 percent reddish-brown, calcareous soils with light-colored surface layers that are low in organic matter. Surface layers and subsoils are moderately coarse to moderately fine textured. Depths to underlying parent material ranges from 30 to more than 60 inches. Most of these soils are suitable for irrigation. Runoff is medium. Water-holding capacities are moderate to high. About 20 percent of the unit has grayish-brown, moderately fine and fine textured soils derived from Mancos Shale. The organic matter content is low and salinity is moderate. The soils are calcareous throughout the profile.

Runoff is rapid and the water erosion hazard is high. The remaining 5 percent consists of shallow soils with gypsum shale or sandstone at depths of 20 inches or less. Most of the gypsum is in the upper reaches of Paradox and Big Gypsum Valleys. These soils have little vegetation and are severely eroded. Runoff is rapid and the erosion hazard is high.

Soil Mapping Unit 3: Rock outcrop and very shallow soils of the canyons
This mapping unit is along the Dolores and San Miguel Rivers and their tributaries. It is the most extensive unit and constitutes about one-third of the basin. Runoff is very rapid because of the steep slopes and shallow soils with low waterholding capacities. Sediment yield is from less than 0.2 to 1.0 acre-feet per square mile per year.

Deep alluvial soils along upper West Creek
included in soil mapping unit 3

The landscape is characterized by deep sandstone canyons with steep slopes and long very narrow valleys, and floodplains. Small, gently sloping mesas are above the canyons. Steeply sloping alluvial fans border some of the canyon walls. Numerous intermittent drainageways dissect the steep slopes. The dominant cover is pinyon-juniper. Oakbrush, serviceberry, and grass are more abundant at higher elevations because of increased precipitation. Willows and cottonwood trees occupy small tracts along the narrow valleys. There are a few irrigated hay fields where the valleys are wider.

This unit is composed of two major components. About 45 percent of the unit is rock outcrop, mainly sandstone, with some small outcrops of shale. Another 49 percent of the unit has shallow soils, less than 20 inches, over underlying sandstone and some shale. These soils are stony and usually have loamy, light-covered surface layers. The remaining 6 percent of the unit is made up of soils with dark-colored surface layers and mixed alluvial soils in the Dolores and San Miguel River bottoms.

Soil Mapping Unit 4: Moderately dark-colored deep soils of the mesas and valleys

This mapping unit occupies several scattered areas from Gateway to Norwood above the Dolores and San Miguel Rivers. Most of the other delineations are along the south and west boundaries of the basin. This unit is of moderate extent and encompasses about 10 percent of the basin.

The landscape is characterized by large, nearly level to gently sloping, upland valleys, and gently sloping mesas. Individual mesas are separated by numerous drainageways that are entrenched to depths of 100 to 500 feet and have steep sandstone walls. The dominant cover is sagebrush with some pinyon-juniper and rabbitbrush. Most of the irrigated and dry cropland and potentially irrigable land of the basin is within this unit.

Most of the soils in this unit are formed in reddish-brown eolian materials. Others are residual or alluvial from sandstone and shale. About 45 percent of the unit is well-drained, deep and moderately deep, with dark-colored surface layers. These soils are noncalcareous to depths of 10 to 24 inches but have slight to moderate zones of lime accumulation. They are moderately coarse to moderately fine textured with subsoils that are usually finer textured than the surface layers. Another 40 percent of the unit is similar to the above except the surface layers are moderately dark-colored and have a lower organic matter content. Depth to calcareous material is 6 to 12 inches. Subsoil textures range from moderately coarse to fine. Lime-cemented cobble and gravel are common below the subsoil. About 10 percent of the unit is less than 20 inches deep over sandstone and shale. The remaining 5 percent consists of alluvial soils in the drainageways.

Soil mapping unit 4 east of Nucla

Soil Mapping Unit 5: Dark-colored soils of the cold mountain slopes
There are several delineations of this unit in both Colorado and Utah. It is one of the most extensive units, comprising about 22 percent of the basin. Although precipitation is plentiful, the short growing season limits crop production to mainly hay and pasture.

The landscape is gently sloping to steep lower mountain slopes with intervening canyons, mesas, and outwash fans. Vegetative cover includes grass, ponderosa pine, serviceberry, oakbrush, aspen, and sagebrush.

About 60 percent of this unit has dark-colored surface layers to a depth of 8 to 24 inches. Organic matter content is high. Surface layers and subsoils are usually medium to fine textured. Depth to underlying parent material, mainly shale and sandstone, is 20 to 60 inches. The soils are noncalcareous to depths of 10 to 30 inches. About 20 percent of the unit is less than 20 inches deep over shale and sandstone. Surface layer thickness ranges from 4 to 10 inches. Textures vary according to parent material. Another 15 percent has dark-colored surface layers with a gray subsurface layer ranging from 2 to 12 inches in thickness. Depth to underlying material is 20 to 60 inches. These soils are neutral to slightly acid. Ponderosa pine or oakbrush are usually dominant on these soils. The remaining 5 percent of the unit consists of mixed alluvial soils, some of which are poorly drained.

Soil Mapping Unit 6: Light-colored soils of the cold mountain slopes
There are several small delineations of this unit which is mostly within national forests. They are in the southeast part of the basin except for one that follows the divide from near Spruce Mountain to the upper reaches of Horsefly Creek. This unit comprises only about 4.5 percent of the basin but has a high water yield.

The landscape is a strongly sloping to steep mountainous terrain dissected by numerous perennial mountain streams. A dense cover of spruce-fir (conifer), mainly Engelmann spruce, is dominant.

Most of this unit has acid forest soils with a surface litter of needles and twigs. About 58 percent of the soils have a dark-colored surface layer less than 4 inches thick. Below this is a light-colored, gray, subsurface layer ranging from 6 to 30 inches thick that is moderately coarse to coarse textured. The underlying subsoil has blocky structure. Textures range from moderately fine to coarse. Some are gravelly or stony. Depth to underlying parent material is usually more than 30 inches. Another 20 percent of the unit is similar to the previous description except that the surface layers are dark-colored to depths of 8 to 20 inches. The gray subsurface layer is 4 to 20 inches thick. About 20 percent of the unit has soils with bedrock at depths of 20 inches or less. The surface layer is dark-colored and about 7 inches thick. The gray subsurface layer is usually absent. The remaining 2 percent is composed of poorly drained alluvial soils along the drainageways.

Soil Mapping Unit 7: Dark-colored soils with light-colored subsurface horizons of the cold mountain slopes
Most of this unit is in national forests at elevations above 7,500 feet. It is all in Colorado except for one area in Utah bordering the La Sal Mountains. This unit is extensive, comprising 22.5 percent of the basin. Precipitation is plentiful and the water yield is high. The short growing season limits crop production to hay and pasture.

The landscape consists of rolling to steep mountainous terrain with intervening canyons, valleys, and outwash fans. There are many springs and perennial streams. The vegetative cover consists of spruce-fir, ponderosa pine, aspen, oakbrush, and some open grassland areas.

About 64 percent of the soils in this unit have dark-colored surface layers, high in organic matter, 7 to 20 inches thick. Underlying this is a light-colored, gray, subsurface layer that is 4 to 16 inches thick. Textures are moderately fine to moderately coarse. Below the gray subsurface layer is a blocky subsoil that is more clayey than the overlying layers. These horizons are neutral to slightly acid. Gravel and stones are often present. The underlying parent material is sometimes calcareous and is usually at depths of 30 inches or more. About 18 percent of this unit has soils that are less than 20 inches deep over parent materials.

Included with these soils are rock outcrops. Another 15 percent of the soils have dark-colored surface layers less than 6 inches thick overlying a gray subsurface layer and blocky subsoils. The soils are slightly acid to acid. Poorly drained alluvial soils compose the remaining 3 percent of the unit.

Soil Mapping Unit 8: Dark-colored soils and rock outcrop of the alpine region

There are seven small delineations of this unit. They encompass high mountain peaks and ridges at elevations above 11,000 feet. This unit is the least extensive in the basin but precipitation and water yield are high. Sediment yield is less than 0.2 acre-feet per square mile per year.

The landscape is characterized by rugged mountain peaks with intervening ridges and valleys, all above timberline. Slopes are steep to very steep. This is a windswept area of alpine meadows and rock.

This unit is mainly composed of three components. All of the soils have dark-colored surface layers and are acid. About 50 percent of the unit is rock outcrop and talus slopes. About 25 percent is shallow well-drained soils high in organic matter. Surface layers and subsoils are usually rocky or stony with moderately sandy textures overlying bedrock at 20 inches or less. Another 20 percent consists of moderately deep, loamy textured, well-drained turf soils containing stone and gravel. Underlying parent material is at depths of 20 to 40 inches. The remaining 5 percent of the unit consist of poorly drained peat and bog soils in low depressions and drainages.

Land Ownership

Twenty-four percent of the land in the basin is privately owned (Table 3). Of this land, about 92 percent is in Colorado and 8 percent in Utah. Seventy-four percent of the land in the basin is owned by the federal government with 74 percent in Colorado and 69 percent in Utah. State ownership is 2 percent of the basin with 32 percent in Colorado and 68 percent in Utah. Details of the land ownership pattern are shown on the Land Ownership Map following page III-16. A graphic presentation of distribution in land ownership is given on the Land Resource Frontispiece 2.

Both the irrigated and dry cropland is in the private ownership delineations. The national forest land in Colorado is within the Uncompahgre, San Juan, and a very small portion of the Grand Mesa National Forests. In Utah it is all within the Manti-La Sal National Forest. Land administered by the Bureau of Land Management is located in the lower elevations of the basin, dominantly around Gateway, Uravan, and Slick Rock.

Table 3.--Land ownership by counties, Dolores River Basin in Colorado and Utah, 1965

	Private	State and local government	Bureau of Land Management	Forest Service	Total
	Acres	Acres	Acres	Acres	Acres
Colorado					
Dolores	130,000	4,800	38,200	341,400	514,400
Mesa	55,400	-	189,000	91,800	336,200
Montezuma	58,300	1,000	3,300	198,800	261,400
Montrose	117,300	-	366,100	223,300	706,700
Ouray	1,200	-	-	200	1,400
San Miguel	302,100	17,200	305,400	174,700	799,400
Total - Colorado	664,300	23,000	902,000	1,030,200	2,619,500
Percent	25.4	0.9	34.4	39.3	100.0
Utah					
Grand	17,200	27,800	95,200	23,000	163,200
San Juan	42,700	20,900	85,400	41,200	190,200
Total - Utah	59,900	48,700	180,600	64,200	353,400
Percent	16.9	13.8	51.1	18.2	100.0
Total - Basin	724,200	71,700	1,082,600	1,094,400	2,972,900
Percent	24.4	2.4	36.4	36.8	100.0

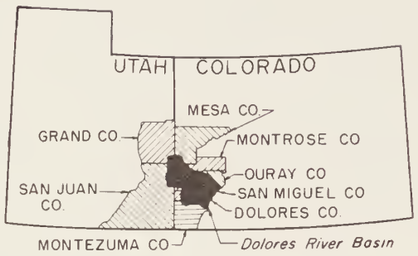
Source: Developed by USDA Field Party

Most of the state and local government land is school land leased to local farm and ranch operators. The Colorado Division of Game, Fish and Parks administers approximately 1,300 acres. There is a small amount of municipal and county controlled land.

LAND OWNERSHIP MAP
DOLORES RIVER BASIN
COLORADO and UTAH

JULY 1968

4 0 4 8
SCALE IN MILES



LOCATION MAP

LAND OWNERSHIP STATUS

- LANDS ADMINISTERED BY THE BUREAU OF LAND MANAGEMENT; WITHDRAWALS AND RESERVATIONS PRIMARILY UNDER B.L.M. JURISDICTION AND VACANT PUBLIC LANDS.
- PRIVATELY OWNED LAND, PATENTED, R. R., MINING AND SMALL HOLDING CLAIMS, CORPORATIONS, CITIES, ETC.
- NATIONAL FOREST LANDS, ADMINISTERED BY THE U.S. FOREST SERVICE.
- STATE OWNED LANDS, INCLUDING THOSE UNDER CONTROL AND TITLE OF STATE FISH AND GAME DEPARTMENTS.

LEGEND

- CITIES AND TOWNS
- RESERVOIR
- COUNTY LINE
- STATE LINE
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-E-20878-N

Land Use and Management

Over 93 percent of the basin is used for some form of agricultural production. The remaining portion includes towns, roads, streams, barren areas (rock and shale), and other areas of miscellaneous use. Agricultural land use includes grazing (or a combination of timber and grazing), irrigated cropland, dry cropland, and timber production. Approximately 68 percent of the basin is used for grazing and most of this area, about 97 percent, is public lands. The 64,600 acres of irrigated and dry cropland is relatively small when compared to other uses, however, it is an important asset to the ranchers and farmers. Over 700,000 acres, nearly 24 percent of the basin, is in nongrazable timber. Timber and grazing is the remainder of the area.

Land administered by the Forest Service and the Bureau of Land Management is managed under principles of multiple use to produce a sustained yield of products and services as authorized and directed by the Multiple Use Acts of June 12, 1960, and September 19, 1964, respectively. The multiple use principle provides for management of the resources of this public land so it is utilized in the combination that will best meet the needs of the American people. The Acts provide for "harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output." There are 27,300 acres of the Wilson Mountains Primitive Area within the San Juan and Uncompahgre National Forests in the basin. Also included is the 2,800 acre Narraguinnep Natural Area in the San Juan National Forest. This land is set aside to preserve and protect its wilderness character.

Land use by ownership is shown in Table 4 and a graphic illustration of agricultural land use appears on the Land Resources Frontispiece 2.

The cover conditions and soils are important factors in the use and management of the land resource. Information relating to these factors are included in the following sections on irrigated cropland, dry cropland, rangeland, and forest land.

Cover conditions vary from dense virgin forest to nearly barren desert areas. Watershed runoff and total water production are generally related to the same factors of elevation, exposure, and effective climate that produce the variations in cover. Total suspended sediment loads from the Dolores River at the gaging station near Cisco, Utah, is 2,524,000 tons per year. This is in the low medium scale when compared to the entire Upper Colorado Region. Most of the higher sediment producing areas of the basin are the more arid, poorly vegetated soils of soil mapping units 1, 2, and 3. Some areas of irrigated and dry cropland, principally in

Table 4.--Agricultural and other land use by ownership, Dolores River Basin in Colorado and Utah, 1965

(1)	Cropland									
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Ownership	Irrigated	Dry	Total (2) & (3)	Noncropland grazing	Forestland and grazing	Total (5) & (6)	Forestland	Other 1/	Total (8) & (9)	River Basin total (4), (7), & (10)
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Colorado										
Private land	45,200	12,000	57,200	184,100	147,600	331,700	212,600	62,800	275,400	664,300
State land	0	0	0	9,100	4,900	14,000	6,000	3,000	9,000	23,000
Federal land										
Bureau of Land Management	0	0	0	296,200	366,300	662,500	177,500	62,000	239,500	902,000
Forest Service										
National Forest	0	0	0	285,500	473,900	759,400	213,500	27,200	240,700	1,000,100
Wilson Mountains Primitive Area	0	0	0	5,400	5,800	11,200	5,300	10,800	16,100	27,300
Narriguinnep Natural Area	0	0	0	0	800	800	2,000	0	2,000	2,800
Total - Colorado	45,200	12,000	57,200	780,300	999,300	1,779,600	616,900	165,800	782,700	2,619,500
Utah										
Private land	3,000	4,400	7,400	10,900	31,000	41,900	8,600	2,000	10,600	59,900
State land	0	0	0	7,900	18,300	26,200	18,600	3,900	22,500	48,700
Federal land										
Bureau of Land Management	0	0	0	58,600	38,100	96,700	59,600	24,300	83,900	180,600
Forest Service	0	0	0	23,500	40,700	64,200	0	0	0	64,200
Total - Utah	3,000	4,400	7,400	100,900	128,100	229,000	86,800	30,200	117,000	353,400
Total - Dolores River Basin	48,200	16,400	64,600	881,200	1,127,400	2,008,600	703,700	196,000	899,700	2,972,900

1/ Includes streams, barren areas (rock and shale), towns, roads, and other miscellaneous uses.

Source: Developed by USDA Field Party

soil mapping units 4 and 5, contribute heavily to the sediment loads. The principal erosive areas are the arid rangelands.

Variable vegetative cover types
(soil mapping units 5, 6, 7, and 8)

The Cropland and Vegetative Cover Map following page III-19 shows the general location of cover types in the basin.

Irrigated Cropland

There are 48,200 acres of irrigated land in the basin. Nearly two-thirds of the irrigated cropland is in the San Miguel River Subbasin. Only 8 percent is in Utah. Approximately 74 percent of the irrigated cropland was originally in the sagebrush and pinyon-juniper woodland, and oakbrush cover types and is in soil mapping units 1, 2, 3, 4, 5, and 7. About 85 percent of the irrigated land is used for hay and pasture. Corn and small grains account for most of the remainder. The hay and pasture yields contribute to the total livestock carrying capacity of the basin and are a vital supplement to the grazing land.

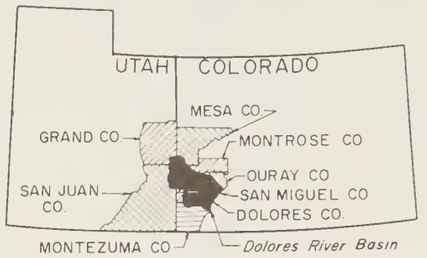
CROPLAND and VEGETATIVE COVER MAP

DOLORES RIVER BASIN

COLORADO and UTAH

JULY 1968

4 0 4 8
SCALE IN MILES



LOCATION MAP

CROPLAND and VEGETATIVE COVER

- Irrigated Cropland
- Nonirrigated Cropland
- Grassland
- Sagebrush
- Pinyon-Juniper Woodland and Oakbrush
- Other Brush
- Coniferous Timber
- Aspen

LEGEND

- CITIES AND TOWNS
- RESERVOIR
- COUNTY LINE
- STATE LINE
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

GPO 845-036 4070-3

Irrigated pasture near Norwood
(soil mapping unit 4)

Dry Cropland

Dry cropland constitutes less than one percent of the basin (Table 5). Approximately 90 percent of the 16,400 acres of dry cropland was originally in the pinyon-juniper woodland, and oakbrush cover type and is in soil mapping units 3, 4, 5, and 7. The predominant cultivated use is dry beans and winter wheat. During 1965, approximately 2,400 acres of small grain and 2,700 acres of dry beans were harvested. An additional 1,100 acres of dry cropland were used for hay, and approximately 4,400 acres were planted to pasture.

The more productive dry cropland is in soil mapping units 4 and 5 which receive 14 to 20 inches of precipitation. Some fields that receive less precipitation than this have been planted to either temporary or permanent pasture. The dry cropland pastures and cropland aftermath grazing are also supplements to the livestock industry.

Table 5.--Cropland and vegetative cover acreages, Dolores River Basin in Colorado and Utah, 1965

Counties	Cropland		Pinyon-juniper, woodland, and oakbrush	Other brush	Sagebrush	Grassland	Other coniferous timber	Aspen	Total
	Irrigated	Non-irrigated							
Colorado									
Dolores	3,100	2,200	61,500	70,900	7,000	72,700	239,900	57,000	514,300
Mesa	2,100	0	196,900	45,600	1,200	0	90,400	0	336,200
Montezuma	5,000	4,800	7,300	42,600	0	13,900	185,100	2,700	261,400
Montrose	15,000	2,200	430,800	61,400	62,800	10,600	104,700	19,300	706,800
Ouray	0	0	0	0	0	200	600	600	1,400
San Miguel	20,000	2,800	343,300	58,400	129,500	70,300	86,900	88,200	799,400
Total - Colorado	45,200	12,000	1,039,800	278,900	200,500	167,700	707,600	167,800	2,619,500
Utah									
Grand	400	0	67,100	62,900	0	8,100	6,400	18,300	163,200
San Juan	2,600	4,400	85,300	19,800	18,600	10,100	33,200	16,200	190,200
Total - Utah	3,000	4,400	152,400	82,700	18,600	18,200	39,600	34,500	353,400
Total - Basin	48,200	16,400	1,192,200	361,600	219,100	185,900	747,200	202,300	2,972,900
Percent of Basin	1.6	0.6	40.0	12.2	7.4	6.3	25.1	6.8	100.0

Source: Developed by USDA Field Party

Dry cropland, winter wheat, near Dolores

The cultivated dry farm cropland acreage will remain low, and perhaps decrease. Dry beans and winter wheat, due to climatic conditions, are not profitable. The emphasis will shift to pasture seedings for livestock use.

Rangeland

The rangeland areas are shown on the Cropland and Vegetative Cover Map following page III-19 and Table 6 -- 2,008,600 acres are considered suitable grazing use.

The natural vegetation of the Dolores River Basin includes a number of grasses, forbs, and shrubs which produce varying amounts of forage depending on the climate and soils of any particular area. Climate exerts the greatest influence on plant growth. Extremes in climate

Table 6.--Range site and forestland acreages by vegetative cover types, Dolores River Basin in Colorado and Utah, 1965

Range and forestland	Vegetative cover 1/						
	Pinyon-juniper woodland, and oakbrush	Sagebrush	Other brush	Other coniferous timber	Aspen	Grassland	Total
Forestland							
Aspen, permanent type, grazable			38,800	21,100	121,200		181,100
Aspen, conditional grazable					29,900		29,900
Aspen, successional, nongrazable			9,700		22,700		32,400
Ponderosa Pine, grazable			5,800	325,600			331,400
Ponderosa Pine, nongrazable			3,900	27,700			31,600
Spruce-Fir, nongrazable			2,400	281,800			284,200
Pinyon-Juniper, grazable	477,700						477,700
Pinyon-Juniper, nongrazable	355,500						355,500
Subtotal	833,200		60,600	656,200	173,800		1,723,800
Dry pasture	47,500	6,700				12,700	66,900
Rock, shale, and miscellaneous land	72,900	6,700	96,500			19,900	196,000
Range site:							
Alpine Grassland				14,300		34,700	49,000
Alpine Meadow						4,000	4,000
Alpine Slopes						15,900	15,900
Brushy Loam			35,800				35,800
Clayey Foothills	28,500	28,900					57,400
Clayey Loam						21,500	21,500
Clayey Saltdesert		29,500					29,500
Clayey Valley				13,900			13,900
Gullied Saltdesert Overflow		6,700					6,700
Loamy Foothills	143,100	85,800					228,900
Loamy Saltdesert		25,300					25,300
Mountain Loam			42,400	38,300		37,500	118,200
Mountain Meadow			3,000				3,000
Mountain Shale			77,200			15,900	93,100
Rocky Foothills	48,000						48,000
Sandy Foothills	9,500						9,500
Sandy Gullied Overflow	9,500						9,500
Silty Saltdesert		29,500					29,500
Subalpine Loam			46,100	24,500	28,500	23,800	122,900
Subtotal	238,600	205,700	204,500	91,000	28,500	153,300	921,600
Total	1,192,200	219,100	361,600	747,200	202,300	185,900	2,908,300

1/ As delineated on the Cropland and Vegetative Cover Map
Source: Developed by USDA Field Party

cause marked differences in the kinds and amounts of native plants. Soil is also important in providing varied forms of vegetation. Each cover type is described separately below.

Other Brush Cover Type ———
This type (278,900 acres in Colorado and 82,700 acres in Utah) is predominately a browse-grass mixture.

Browse plants are sometimes called chaparral and include oakbrush, juniper, squawapple, mountain mahogany, serviceberry, currant, snowberry, rose, bitterbrush, willow, chokecherry, skunkbush, sagebrush, and rabbitbrush. The more common grasses are wheatgrass, bluegrass, bromegrass, needlegrass, fescue, grama, Junegrass, muhly, Indian ricegrass, and wildrye grass.

The above plants make this cover type an important wildlife area. Soil and moisture conditions are generally favorable for native range forage production, and the higher carrying capacities for livestock grazing are in this cover type. Abandoned dry cropland provides in parts of this cover type dry pasture seeding sites. These rangelands respond favorably to practices such as brush control, range and pasture seeding, herding, stock water development, proper salting, and fencing for better livestock distribution.

Range sites include Mountain Shale (77,200 acres), Brush Loam (35,800 acres), Subalpine Loam (46,100 acres), Mountain Loam (42,400 acres), and Mountain Meadow (3,000 acres). Woodlands include grazable Aspen permanent type (38,800 acres), successional stage nongrazable Aspen (9,700 acres), Spruce-Fir nongrazable (2,400 acres), Ponderosa Pine grazable (5,800 acres), and Ponderosa Pine nongrazable (3,900 acres). Estimated animal unit months of grazing is 31,800 for present conditions.

Grassland Cover Type ———
This type (167,700 acres in Colorado and 18,200 acres in Utah) is predominately native grassland.

This cover type will usually have a scattering of shrubs which are native to the precipitation zone in which they occur. The most common grasses are wheatgrass, bluestem, fescue, squirreltail, needlegrass, Indian ricegrass, bromegrass, with blue grama and galleta becoming abundant at the lower elevations. In the alpine and montane forest zones the more common plants include sedges, rush, trisetum, vetch, kobresia, bluegrass, tufted hairgrass, timothy, bentgrass, bromegrass, willows, bluebells, clover, fescue, wheatgrass, and oatgrass.

Grassland cover type

Much of the livestock grazing capacity is dependent on this cover type and the scattering of similar range site vegetation in the other cover types which are inclusions too small to delineate. Especially in the higher elevations, grass islands occur as small parks too small to delineate, but total enough acreage to contribute to the livestock carrying capacity. Dry pastures are an important part of the range inventory in this cover type. Brush control, range and pasture seeding, proper salting, herding, stock water development, and fencing are common practices to improve these rangelands.

Range sites include Alpine Grassland (34,700 acres), Mountain Loam (37,500 acres), Clayey Loam (21,500 acres), Subalpine Loam (23,800 acres), Mountain Shale (15,900 acres), Alpine Slopes (15,900 acres), and Alpine Meadow (4,000 acres). The present estimate of animal unit months of grazing is 27,900.

Aspen Cover Type ———
This type (167,800 acres in Colorado and 34,500 acres in Utah) is predominately aspen tree cover type. Inclusions are estimated at 14 percent grassland.

Aspen cover type
(soil mapping unit 7)

Much of this cover type has dense to moderately dense stands of aspen with a bush understory of forage plants. There are numerous grass or meadow parks which contribute to the grazing capacity. The cover type contribution as a forage unit is for summer grazing by both livestock and wildlife. Fencing, proper salting, herding, and development of stock water are the principal practices applicable to this cover type.

Woodlands and range sites include grazable permanent type Aspen (121,200 acres), conditional grazable type Aspen (29,900 acres), nongrazable type Aspen (22,700 acres), and Subalpine Loam (28,500 acres). The present estimate of animal unit months of grazing is 26,500.

Coniferous Timber Cover Type ———
This type (707,600 acres in Colorado and 39,600 acres in Utah) is predominately ponderosa pine, spruce, or fir. Inclusions are estimated at 12 percent grassland, and 3 percent aspen.

Coniferous timber cover type

This cover type can generally be considered as subalpine and montane forest areas. Where the tree stands are dense, particularly in the spruce and fir areas, there is very little undergrowth. Ponderosa pine forms open stands in which there are a variety of understory plants. These include mountain muhly, Junegrass, needlegrass, bromegrass, sedge, rush, fescue, wheatgrass, oatgrass, sagebrush, serviceberry, mountain mahogany, and bitterbrush.

Much of the summer grazing of both livestock and wildlife occurs in this cover type. Grassland inclusions produce an important part of the grazing capacity. Forest Service land is a big part of these delineations.

This cover type is used extensively for recreation. It is the summer habitat for large numbers of deer and elk. Fishing, skiing, big game hunting, and much of the tourist use are in these areas.

Woodlands include grazable Ponderosa Pine (325,600 acres), nongrazable Spruce-Fir (281,800 acres), Aspen grazable permanent type (21,100 acres), and nongrazable Ponderosa Pine (27,700 acres). Range sites include Mountain Loam (38,300 acres), Clayey Valley (13,900 acres), Alpine Grassland (14,300 acres), and Subalpine Loam (24,500 acres). The present estimate of animal unit months of grazing is 49,800.

Sagebrush Cover Type ———
This type (200,500 acres in Colorado and 18,600 acres in Utah) is predominately sagebrush.

Sagebrush cover type
(soil mapping unit 4)

Sagebrush generally is found on favorable soils for plant growth, however, the precipitation is below the required level for good nonirrigated farming in this basin. There are numerous scatterings of grassland and dry pastures in this cover type which contribute to the livestock carrying capacity. Some of the brush and grass vegetation listed in the grass and other brush cover types can be found in the understory or as inclusions in this cover type.

These rangelands respond favorably to practices such as brush control, range and pasture seeding, stock water development, and fencing for better livestock distribution. The land also serves as critical winter range for wildlife.

Range sites include Silty Saltdesert (29,500 acres), Clayey Saltdesert (29,500 acres), Loamy Saltdesert (25,300 acres), Loamy Foothills (85,800 acres), Clayey Foothills (28,900 acres), and Gullied Saltdesert overflow (6,700 acres). The present estimate of animal unit months of grazing is 13,400.

Pinyon-Juniper Woodland and Oakbrush Cover Type ———
This type (1,039,800 acres in Colorado and 152,400 acres in Utah) is predominately pinyon-juniper.

This is the largest of the cover type delineations and is quite varied regarding grazing capacity. Some is too steep to graze, and other areas are rock outcrops or rocky surfaces with little vegetative understory. Sagebrush and dry pasture inclusions contribute considerably to the total grazing capacity. This cover type is generally at elevations below 6,000 feet and in the lower precipitation zones.

Grasses include grama grass, little bluestem, bromegrass, fescue, Junegrass, muhly grass, galleta, wheatgrass, and Indian ricegrass.

Abandoned dry cropland in the cover type can be seeded to dry pasture. The better soil and slope patterns respond to range and pasture seedings. Other practices include brush control, proper salting, herding, stock water development, and fencing for better livestock distribution. Much of this cover type is an important part of the winter range for wildlife.

Woodlands include Pinyon-Juniper grazable woodland (477,700 acres), and Pinyon-Juniper nongrazable woodland (355,500 acres). Range sites include Rocky Foothills (48,000 acres), Loamy Foothills (143,100 acres), Clayey Foothills (28,500 acres), Sandy Foothills (9,500 acres), and Sandy Gullied Overflow (9,500 acres). The present estimate of animal unit months of grazing is 55,100.

Forestland

Approximately 1-3/4 million acres or 60 percent of the basin are forested or wooded land. Commercial forest land occupies 740,000 acres or about 42 percent of the forested area. About 30 percent of the area is in the ponderosa pine type and occurs at the lower altitudinal range of the commercial timber species. Another 25 percent of the area supports the

spruce-fir type at elevations above 9,000 feet. In between these two altitudinal zones there occur various combinations of mixed forest types, which are classified as either Douglas fir-white fir or as aspen, depending on stand composition. Of the total commercial forest area, 88 percent is in the national forests (Tables 7 and 8 pages III-34 and III-35). Forest land in the study area is classified into seven major types, four of which are considered commercial.

Commercial Cover Types ———

Spruce-fir ——— This type occurs at elevations from 9,000 feet to 11,500 feet. The predominant tree species is Englemann spruce (Picea engelmanni), which comprises from 75 to 95 percent of the total volume in mature stands. Corkbark fir (Abies lasiocarpa var. arizonica) is its most common associated species. At lower altitudinal limits, Douglas fir and aspen are associated with the spruce.

Almost half the spruce-fir type, or 97,000 acres, is overmature. The age of the sawtimber stands varies from 90 to 300 years, with an average of 170 years. This is based on increment borings taken of randomly selected trees by the last national forest survey. The net sawtimber volume in these stands averages about 17.5 Mbf per acre over large national forest areas, with individual stands varying from 13 Mbf to as much as 35 Mbf per acre.

In the younger classes, 27,500 acres were classified as pole stands, 14,000 acres as seedlings and saplings, and 5,100 acres as nonstocked. The nonstocked land is mostly old burns where natural regeneration has not taken place. Numerous old burns are still nonstocked after 70 to 90 years.

Some advance reproduction of spruce and fir is usually present in older stands which have begun to break up, but natural reproduction is very slow to come in after logging where extensive cleanup has been practical. Partial cutting which is now being practiced on the national forests will considerably relieve the need for artificial regeneration in this type.

Ponderosa pine ——— (Pinus ponderosa) This type occurs across the entire basin at elevations from 6,500 to 8,500 feet. It occurs in pure stands within its lower and middle altitudinal range. The degree of stocking is at an optimum in its middle range on shallow, sandy soils. On north-facing slopes, Douglas fir is a common associate, occasionally replacing the pine altogether. Toward the upper limits of the pine belt other species such as white fir, aspen, and Douglas fir become more prevalent.

Total commercial area for the ponderosa pine type is about 250,000 acres, 82 percent of which is classed as sawtimber. Most of the area has been cut over at least once during the last 70 years. In general, present degree of stocking is not good, since about 40 to 45 percent of the total pine area is classified as poorly stocked or nonstocked. Large areas have been taken over by oakbrush.

Second growth stand of ponderosa pine,
San Juan National Forest

Stands consist generally of a myriad of small, even-aged groups of trees. Stand density varies from a few scattered trees to full stocked stands of 10 to 20 Mbf per acre. Occasionally small areas support volumes of 50 Mbf per acre.

Advance young growth of seedlings, saplings, poles, and small thrifty sawtimber trees are common. The silvicultural practice favored is the group selection system where repetitive partial cutting is applied. Clear cutting in small patches may also be used, but there is a tendency in this basin for aspen to take over whenever the stand is opened. Although conifers will eventually crowd the aspen in such a case, benefits from obtaining prompt regeneration of conifers may be lost.

Douglas fir-white fir ——— At elevations from 8,500 to 9,500 feet, the pine gives way to a mixed conifer type whose principal components are white fir (Abies concolor) and Douglas fir (Pseudotsuga menziesii). Numerous other species occur in this type, including ponderosa pine at lower elevations and Engelmann spruce and corkbark fir at higher altitudes. Aspen (Populus tremuloides) is usually well represented in the Douglas fir-white fir stands. Occasionally Douglas fir occurs in pure stands, especially in steep northerly exposures, but there is usually a mixture of several species. The sites occupied by this type are potentially the most productive on the forest as evidenced by the large size of the Douglas fir, spruce and aspen trees found there. The soils are relatively deep and fertile, and the terrain is generally characterized by numerous benches alternating with short, steep slopes in a stairstep fashion. The total area of commercial Douglas fir-white fir type within the basin is about 30,000 acres practically all of which is sawtimber.

Aspen ——— (Populus tremuloides) The aspen type occurs at elevations from 8,500 to 10,000 feet, occupying essentially the same altitudinal zone as Douglas fir-white fir type and infringing upon the lower limits of the spruce zone. Total area of commercial timber within this type is 261,000 acres, 75 percent of which is sawtimber and 25 percent poletimber -- seedling-sapling stands and nonstocked areas.

The aspen type became established as a result of repeated burns which eventually eliminated the conifers that normally occupied these sites as the climax forest type. Aspen attains its best development at elevations above 9,000 feet and often occurs in mixtures with spruce and firs above 9,000 feet. Aspen stands are rather extensive throughout the basin and commonly occupy mesa lands immediately below the spruce zone.

Aspen stands are even-aged in character. Overmature sawtimber stands often carry a rather well-stocked understory of pole-size timber thus making up a two-storied stand. This is an unusual characteristic of aspen peculiar to this basin. The average age of sawtimber stands is approximately 120 years, while the pole stands vary from 40 to 80 years. All age classes are generally well stocked.

It is estimated that half the aspen area is on sites capable of growing small sawtimber within a rotation period of 70 years. Growth rate on these sites will average better than 100 board-feet per acre per year, yielding better than 10 Mbf per acre at maturity. The remaining half of the area is estimated to be on sites from which only a pole or pulpwood yield could be expected. The current average annual net growth is approximately six cubic-feet per acre.

Aspen reproduces by sprouts and suckers. This new growth comes in profusely following logging to assure rapid regeneration of harvested areas.

Other Vegetative Types ———

Blue Spruce ——— (Picea pungens) This species does not form a pure stand in the forest but mixes with spruce-fir, aspen, and ponderosa pine stands between 7,500 and 9,000 feet. It prefers a moist site and is most generally found along stream bottoms.

Pinyon-Juniper ——— This type covers a sizable area. It consists of two junipers (J. scopulorum and J. osteosperma) and pinyon pine (Pinus app.). It is principally found on west and southwest slopes between 6,000 and 8,000 feet elevation. Chief value of this type is for posts, fuel, Christmas trees, and watershed protection. These posts played an important part in the fencing of homesteads and ranches as the valleys were settled. During the 1930's many posts were cut and sold to eke out a living by ranchers on submarginal land. Today practically all of this type has been cut over both on the national forests and adjoining land. There is a possibility that a charcoal industry could be established to utilize pinyon and juniper wood.

Oakbrush ——— (Quercus gambellii) This type invades the ponderosa pine zone following repeated fires and now occupies large areas originally occupied by ponderosa pine. A market has not been developed for oakbrush, and it presents a management problem. It provides feed for big game animals, but in general deep snow forces game animals down below this type. Therefore, it does not provide feed during critical winter months. Oakbrush occupies many good ponderosa pine sites.

Table 7.--Area of commercial forest land by forest types, stand-size class, and ownership, Dolores River Basin in Colorado, 1967

Forest type and ownership	Commercial forest land				
	Saw timber	Pole timber	Seedings and sapling	Non-stocked	Total
	Acres	Acres	Acres	Acres	Acres
Douglas fir-white fir					
National forest	18,600	3,400	-	-	22,000
BLM	1,800	-	-	-	1,800
State and private	3,400	3,000	-	-	6,400
Total	23,800	6,400	-	-	30,200
Ponderosa pine					
National forest	190,800	15,300	800	20,300	227,200
BLM	1,600	-	-	2,200	3,800
State and private	4,600	5,150	-	-	9,750
Total	197,000	20,450	800	22,500	240,750
Spruce-fir					
National forest	154,900	25,000	1,400	5,100	186,400
BLM	-	-	-	-	-
State and private	5,500	2,450	-	-	7,950
Total	160,400	27,450	1,400	5,100	194,350
Aspen					
National forest	180,600	9,000	10,073	1,327	201,000
BLM	-	700	-	-	700
State and private	14,140	41,360	-	-	55,500
Total	194,740	51,060	10,073	1,327	257,200
Total forested land					
National forest	544,900	52,700	12,273	26,727	636,600
BLM	3,400	700	0	2,200	6,300
State and private	27,640	51,960	0	0	79,600
Total	575,940	105,360	12,273	28,927	722,500

Source: Developed by USDA Field Party

Table 8.--Area of commercial forest land by forest types, stand-size class, and ownership, Dolores River Basin in Utah, 1967

Forest type and ownership	Commercial forest land				
	Saw timber	Pole timber	Seedlings and sapling	Non-stocked	Total
	Acres	Acres	Acres	Acres	Acres
Douglas fir					
National forest	80	-	-	-	80
BLM	-	-	-	-	-
State and private	-	-	-	-	-
Total	80	-	-	-	80
Ponderosa pine					
National forest	8,240	10	-	-	8,250
BLM	-	700	-	-	700
State and private	100	20	-	-	120
Total	8,340	730	-	-	9,070
Spruce-fir					
National forest	4,190	50	20	-	4,260
BLM	-	-	-	-	-
State and private	-	-	-	-	-
Total	4,190	50	20	-	4,260
Aspen					
National forest	60	3,950	130	-	4,140
BLM	-	-	-	-	-
State and private	-	110	-	-	110
Total	60	4,060	130	-	4,250
Total forested land					
National forest	12,570	4,010	150	-	16,730
BLM	-	700	-	-	700
State and private	100	130	-	-	230
Total	12,670	4,840	150	-	17,660

Source: Developed by USDA Field Party

Typical pinyon-juniper woodlands
with sagebrush industry near Dolores

Water Resources

Water Supply

The Dolores River and its principal tributary, the San Miguel River, originate in the high slopes of the San Juan Mountains. Most of the water yield is provided by melting winter snowpack. About 16.9 percent of the annual percipitation, or an average 2.9 inches occurs as water yield. About 20 percent of the basin area produces 85 percent of the water supply.

About seven percent of the State of Colorado's contribution to runoff in the Colorado River Basin originates in the Dolores River Basin.

The basin produces 5.35 percent of the combined streamflow of the Colorado and Paria Rivers at Lees Ferry, Arizona. (Annual average for the water years 1914-57 adjusted to 1957 conditions).

Summer precipitation does augment total yield by an insignificant amount. High spring runoff months of May and June produce an average 306,000 acre-feet (56 percent) of stream discharge from the basin. This results from melting winter snowpacks which accumulate from winter moisture of October through April during which 60 percent of annual precipitation occurs. Extremes in yield vary from alpine areas producing 35 inches to desert areas producing insignificant amounts.

The Average Annual Water Yield Map (1943-60 period) for the basin follows page III-38. This map was primarily developed from streamflow records with correlation to climatological data (snow and winter precipitation records), soil types, range site descriptions, vegetal cover, and physical aspects of contributing watersheds. Table 9 is a summary of streamflow records at selected points in the basin.

Total undepleted water supply [4/] at the Dolores River confluence with the Colorado River averaged 716,400 acre-feet annually during the 1943-60 period. Diminishment of the water supply by uses other than man-related, such as forests, native pasture and range vegetation, wildlife and natural lake evaporation, are excluded from this total. (The basin is divided into two hydrologic units for water resource evaluation. These divisions and a diagrammatic summary of the water resource inventory are shown on Frontispiece 1.) The San Miguel River and Colorado portion of the Dolores River produced 690,200 acre-feet (96 percent) of the total water supply while the contributing areas in Utah produced 26,200 acre-feet (4 percent).

No water is imported into the Dolores Basin, and ground water contributes only slightly to the total water supply. It is estimated that less than one percent of the total irrigation water requirement is supplied by ground water. Nine reservoirs and three enlarged lakes with capacities of 200 acre-feet or more have been developed to provide water for irrigation, municipal and industrial use, and recreation benefits. In addition, over 2,000 smaller reservoirs have been built primarily for stock water and irrigation use. Evaporation losses from these man-related developments were included in the basin depletion analysis (Table 11, page III-44).

[4/] Total undepleted water supply as used herein indicates the aggregate natural runoff prior to man-related depletions.

Table 9 .--Summary streamflow records at selected points in the Dolores River Basin

Stream	Drainage area (square miles)	Years of record	Average discharge		Extremes of discharge (cubic feet per second)	
			Cubic feet per second	Acre-feet per year	Maximum	Minimum daily
Dolores River below Rico	105	11	133	96,290	2,120	7.0
Dolores River at Dolores	556	51	440	318,500	10,000	8.0
San Miguel River near Placerville	308	26	232	168,000	10,000 1/	26.0
San Miguel River at Naturita	1,080	34	360	260,600	7,100	5.8
Dolores River at Gateway	4,350	18	938	679,100	15,400	23.0

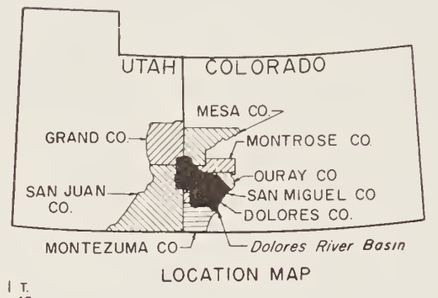
1/ Result of failure of Trout and Middle Reservoir Dams in September 1909.

Source: U. S. Geological Survey

AVERAGE ANNUAL WATER YIELD
DOLORES RIVER BASIN
COLORADO and UTAH

JULY 1968

4 0 4 8
SCALE IN MILES



LOCATION MAP

1943-60
AVERAGE ANNUAL WATER YIELD

- Below 0.1 inch
- 0.1 to 1 inch
- 1 to 5 inches
- 5 to 10 inches
- 10 to 20 inches
- 20 to 30 inches
- 30 to 40 inches
- ▲ 1234 Streamgage Station and Number

LEGEND

- CITIES AND TOWNS
- RESERVOIR
- COUNTY LINE
- STATE LINE
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

4070-6

GPO 851-357

Confluence of the Dolores and San Miguel Rivers

Average annual discharge [5/] of the Dolores River to the Colorado River was estimated at 544,000 acre-feet for the 1943-60 period. The Colorado portion of the basin contributed 524,200 acre-feet (96 percent) and the Utah portion contributed 19,800 acre-feet (4 percent).

Water Quality

Water quality of runoff is high, but deterioration does take place as the water moves to the Colorado River. Man-related depletions affect

---

[5/] Average annual discharge is the total water supply minus man-related stream depletions.

concentration of dissolved solids. A large natural contribution of 230,000 tons of dissolved solids annually by a four-mile anticlinal structure composed of 75 percent salt and gypsum at the junction of Paradox Valley on the Dolores River is the major source (50 percent of the total) of salinity to water leaving the basin.

Three factors generally associated with water quality are dissolved solids, suspended sediment, and pollution by industrial or human contaminates. This basin has very little industrialization and population densities are low. Water quality factors, therefore, are generally limited to dissolved solids and suspended sediment in the basin.

The communities of Dolores, Naturita, Nucla, Uravan, Vancorum, Norwood, and Telluride have slightly less than half the total basin population. They all treat their sewage prior to releasing it to a receiving stream. Dolores has a septic tank type system. Naturita, Uravan, and Vancorum have secondary treatment plants. Nucla has a lagoon type system and Norwood has a primary treatment plant. (Table 10 lists data on sediment and dissolved solids as reported by the U. S. Geological Survey). Additional U. S. Geological Sruvey information is as follows:

(1) The basin produces 2.43 percent of the combined suspended sediment discharge and 5.31 percent of the combined dissolved solids discharge of the outflow of the Colorado and Paria Rivers at Lees Ferry, Arizona. (The 2.43 percent is an annual average for the water years 1952-57).

(2) The weighted average concentration of dissolved solids for the basin water discharge is 496 ppm near the mouth of the Dolores River at the Dolores River Cisco Gage. The range is 200 to 6,000 ppm, and is more than 1,000 ppm 60 percent of the time. At Dolores, the river contains 100 to 300 ppm 90 percent of the time. At Bedrock, above the confluence of the Dolores and San Miguel Rivers, the concentration has exceeded 1,200 ppm. The basin adds an average of 460,200 tons of dissolved solids annually to the Colorado River. The Gypsum and Paradox Valleys together contribute 251,000 tons per year of this. These dissolved solids are picked up where the Dolores River crosses two collapsed salt anticlines. The Paradox Valley location is a four-mile reach of the Dolores River that is estimated to pick up about 230,000 tons of dissolved solids annually. This is one of the major sources of salt to the Colorado River and represents 50 percent of the Dolores River contribution to the Colorado River.

Table 10.--Concentration and discharge of dissolved solids and suspended sediment for streams in the Dolores River Basin. (Data represent annual average for the water years 1914-57 adjusted to 1957 conditions.)

Stream	Water discharge (thousands of acre-feet per year)	Dissolved solids			Suspended sediment		
		Weighted-average concentration (ppm)	Discharge		Weighted-average concentration (ppm)	Discharge	
			Thousands of tons per year	Tons per square mile per year		Thousands of tons per year	Tons per square mile per year
Dolores River at Dolores	356	125	61	109	245	119	214
Lost Canyon Creek at Dolores	22	57	1.7	21	-	-	-
San Miguel River near Placerville	188	157	40	130	-	-	-
San Miguel River at Naturita	254	316	109	101	-	-	-
Dolores River at Gateway	684	475	442	102	-	-	-
Dolores River near Cisco	681	496	460	99	3,370 1/	2,524 1/	545 1/

1/ For water years 1952-57.

Source: U. S. Geological Survey

(3) The Dolores Basin produces about one-sixth of the total suspended sediment load of the Colorado River at the station near Cisco, which is just below the mouth of the Dolores River. This is a weighted average concentration of 3,370 ppm, 2,524,000 tons per year, or 545 tons per square mile per year for the Dolores River Basin.

Water Rights

Appropriation of water in the State of Colorado is authorized by the state constitution and by certain statutes adopted pursuant to the constitution. Unappropriated water of any natural stream of the state is subject to appropriation for beneficial use under the doctrine of the first in time is first in right to the continued use of the water.

A person who wishes to obtain a water right must acquire an appropriation of the water desired. Normally the first step is to make a survey or construct the necessary facilities which will divert the water for application of the water to a beneficial use. The person then makes application for the water right to the water clerk in the appropriate water division. Procedure is given in the statutes for notice, publication, opposition statements and investigations and rulings by the water referee. The water judge then hears and rules on protests to the referee's ruling. Provision is made for appellate review.

Provisions are given in the statutes for conditional water rights, changes of water rights, approval for augmentation, the integration of ground water systems into the priority system, tabulations, abandonment procedure and related matters.

The Colorado State Engineer, along with his duly authorized representatives, has the duty of administering the distribution of water in accordance with decrees. He also has the duty to see that waters of the state are preserved for the use and benefit of the citizens and inhabitants of the state, and are not wasted.

Except for a very small drainage area in eastern Utah, the Dolores River originates entirely within Colorado. During the flood period of the year, which occurs in the spring, the Dolores River and its tributaries carry quantities of unappropriated water. The Southwestern Colorado Water Conservation District has filed on over 360,000 acre-feet which is essentially the remaining unappropriated Colorado water for the proposed Dolores Project of the U. S. Bureau of Reclamation. Therefore, there is little chance to establish new water rights in Colorado on the water originating above the project.

Because of the rough and mountainous nature of the Utah drainage area, it is unlikely that developments requiring new water rights will be established on the Dolores River or its tributaries in that state.

Water Use

This report is essentially limited to a land and water resource inventory, including a comprehensive assessment of the problems, needs, resources, and impacts of potential developments in the basin. Operational aspects and design details of proposed developments are not a consideration of this study. All in-basin depletions described herein are onsite consumptive use estimates and do not include any losses between the point of diversion and the point of application. Water exported from the basin constitutes a direct stream depletion, with respect to the Dolores River, regardless of its ultimate use. Therefore, consumptive use estimates were not prepared for water exported and used in other basins.

Total average annual man-related water depletions in the basin were 172,400 acre-feet during the 1943-60 period (Table 11). Onsite depletions, not attributable to man, were not included in the analysis. These include use by forests, native range and pasture vegetation, wilflife, and natural lake evaporation. Water resource depletions, as used in this report, are estimates of water consumptively used by man's activities and do not represent the total amount of water diverted from natural streamflows. Water exported for use in other basins is the major depletion of the water resource originating in the Dolores Basin.

Four out-of-basin exports totaling 115,700 acre-feet (67 percent of the total annual depletion) were in operation during the 1943-60 period (Frontispiece 1). The Leopard Creek Ditch diverted an average 2,300 acre-feet annually from the San Miguel River Subbasin to the Gunnison River Basin. Two irrigation companies, Montezuma Valley and Summit, exported 105,000 and 6,400 acre-feet respectively, from the Dolores River near Dolores to the Cortez area in the San Juan River Basin. (Historical diversion records were used to establish these annual averages). The fourth diversion, located near La Sal, Utah, is estimated to have averaged 2,000 acre-feet annually. (No diversion records are available and estimates were based primarily on acreage irrigated, crop consumptive use requirements, and size of the diversion ditch).

The major use of water in the basinis for irrigation of crops. An estimated annual average of 47,050 acres was irrigated during the 1943-60

Table 11.--Average annual water depletions, Dolores River Basin in Colorado and Utah, 1943-60

Water depletions	Colorado 1/		Utah 1/		Percent of total
	Dolores Main Stem Subbasin	San Miguel River Subbasin	Dolores Main Stem Subbasin	Basin total	
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	
Consumptive use:					
Irrigated crops 2/	16,600	26,700	4,000	47,300	27.4
Riparian vegetation, non-beneficial phreatophytes, seeped lands and incidental areas 3/	2,600	500	200	3,300	1.9
Industrial, municipal, domestic and livestock use, and reservoir evaporation	3,100	2,800	200	6,100	3.6
Total consumptive use	22,300	30,000	4,400	56,700	32.9
Export: 4/					
Water transported out-of-basin	111,400	2,300	2,000	115,700	67.1
Total depletion	133,700	32,300	6,400	172,400	100.0

1/ See Water Resource Frontispiece 1 for basin divisions.

2/ 47,050 acres of irrigated land, 44,050 acres in Colorado, 3,000 acres in Utah.

3/ Estimates of water depletion resulting from riparian vegetation and nonbeneficial phreatophytes may in some instances include consumptive water use due to natural conditions that are impossible to separately identify and differentiate from man-related developments.

4/ Export for 1943-60 period developed from diversion records and areas irrigated.

Source: Developed by USDA Field Party

Water export from the Dolores River to the San Juan River Basin - Montezuma Valley Irrigation Company Canal

period with a net consumptive use 6/ of 47,3000 acre-feet (27 percent of the total depletion). Hay and pasture were produced on 41,000 acres (87 percent) of the irrigated land. The irrigation use in Colorado was divided with 26,7000 acre-feet (56 percent of the basin total) used in the San Miguel River Subbasin and 16,600 acre-feet (35 percent) in the Dolores Main Stem Subbasin. The irrigation use in Utah amounted to 4,000 acre-feet (over 8 percent). The Utah portion of the basin is tributary to the Main Stem of the Dolores River. Blaney-Criddle procedures, based on climatic records and average crop acreage distributions for the 1943-60 period, were used to compute the net consumptive use by irrigated crops. Adjustments in growing season dates were made to compensate for variations in adequacy of water supplies for water-short areas.

6/ Net consumptive use, as used herein, as the amount of water, excluding effective precipitation, used in evapotranspiration by a crop during its growing season.

Remaining man-related depletions totaling 9,400 acre-feet (almost 6 percent) include: (1) industrial, 300 acre-feet, (2) domestic, 1,000 acre-feet, (3) livestock, 500 acre-feet, (4) nonbeneficial phreatophytes, 3,300 acre-feet, and (5) reservoir evaporation, 4,300 acre-feet. Use by nonbeneficial phreatophytes [7/] was estimated using Blaney-Criddle procedures and U. S. National Weather Service data for the 1943-60 period. The evaporation losses were estimated by correlating evaporation losses from Class A Land Pans, at U. S. National Weather Service stations adjacent to the basin, to reservoir evaporation and applying the factors developed to surface areas of reservoirs in the basin. [8/]

Depletions increased by 34,100 acre-feet (20 percent) from the 1943-60 annual average to the present, (1965) Table 12. Increase in out-of-basin export was the major factor, with an increase of 28,800 acre-feet up 25 percent) in 1965. Industrial use increased 3,000 acre-feet (10 times greater) due to the coal-fired electric generating plant near Nucle (completed in 1959). Irrigation use increased 1,300 acre-feet (up 3 percent) due to the slightly greater acreage under irrigation. Other increases amounting to 1,000 acre-feet were reservoir evaporation (800 acre-feet) and domestic use (200 acre-feet).

Potential Water Use

Water depletions were estimated and potential developments projected for the 1965-80, 1980-2000, and 2000-2020 time frames. Total annual depletions of the basin's water supply are estimated to average 433,100 acre-feet in 2020. This is 2½ times the average annual depletion (172,400 acre-feet) estimated for the 1943-60 period (Table 13).

Precipitation and streamflow are highly variable from year to year and are governed primarily by chance processes. Investigations could not be made in sufficient detail to make accurate forecasts of future streamflows. Therefore, data presented are based on water supply assumptions relative to the 18-year period, 1943-60.

7/ For this report, "nonbeneficial phreatophytes" are nonagricultural plants that obtain their water supply from the zone of saturation. These plants are considered to be of little or no apparent beneficial use such as erosion protection for streambanks, shade and cover for livestock, shade for picnic and campgrounds, and others.

8/ Procedures are outlined in Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Paper 1104. Also, USGS Paper 272-D, Evaporation from the 17 Western States.

Table 12.--Water depletions, Dolores River Basin in Colorado and Utah, 1965

Water depletions	Colorado 1/		Utah 1/		Percent of total
	Dolores Main Stem Subbasin	San Miguel River Subbasin	Dolores Main Stem Subbasin	Basin total	
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	
Consumptive use:					
Irrigated crops 2/	17,300	27,300	4,000	48,600	23.5
Riparian vegetation, non-beneficial phreatophytes, seeped lands and incidental areas 3/	2,600	500	200	3,300	1.6
Industrial, municipal, domestic and livestock use, and reservoir evaporation	3,200	6,700	200	10,100	4.9
Total consumptive use	23,100	34,500	4,400	62,000	30.0
Export: 4/					
Water transported out-of-basin	140,200	2,300	2,000	144,500	70.0
Total depletion	163,300	36,800	6,400	206,500	100.0

1/ See Water Resource Frontispiece 1 for basin divisions.

2/ 48,200 acres of irrigated land, 45,200 acres in Colorado, 3,000 acres in Utah

3/ Estimates of water depletion resulting from riparian vegetation and nonbeneficial phreatophytes may in some instances include consumptive water use due to natural conditions that are impossible to separately identify and differentiate from man-related developments.

4/ Export for 1965 developed from diversion records and areas irrigated.

Source: Developed by USDA Field Party

Table 13.--Average annual water supply and river basin discharge, (acre-feet) Dolores River Basin in Colorado and Utah, 1943-60, and projected developments by 1980, 2000, and 2020

Item	1943-1960			1980			2000			2020		
	Colorado	Utah	Total	Colorado	Utah	Total	Colorado	Utah	Total	Colorado	Utah	Total
Irrigated crops 1/ (net consumptive use) 2/	43,300	4,000	47,300	44,400	3,900	48,300	84,800	3,900	88,700	84,800	3,900	88,700
Riparian vegetation, non-beneficial phreatophytes, seeped lands, and incidental areas 3/ (net consumptive use) 2/	3,100	200	3,300	3,100	200	3,300	4,800	200	5,000	4,800	200	5,000
Industrial, municipal, domestic and livestock use and reservoir evaporation	5,900	200	6,100	17,300	300	17,600	25,400	300	25,700	49,200	300	49,500
Export, water transported out-of-basin	113,700	2,000	115,700	271,900	2,000	273,900	271,900	2,000	273,900	287,900	2,000	289,900
Total depletion	166,000	6,400	172,400	336,700	6,400	343,100	386,900	6,400	393,300	426,700	6,400	433,100
Total water yield 4/	690,200	26,200	716,400	690,200	26,200	716,400	690,200	26,200	716,400	690,200	26,200	716,400
Import	0	0	0	0	0	0	0	0	0	0	0	0
Total undepleted supply	690,200	26,200	716,400	690,200	26,200	716,400	690,200	26,200	716,400	690,200	26,200	716,400
River basin discharge 5/ (supply minus depletion)	524,200	19,800	544,000	353,500	19,800	373,300	303,300	19,800	323,100	263,500	19,800	283,300

1/ Estimated irrigated acreage: 1943-60 = 44,050 acres in Colorado, 3,000 acres in Utah; 1980 = 43,900 acres in Colorado, 3,000 acres in Utah; 2000 and 2020 = 70,000 acres in Colorado, 3,000 acres in Utah.

2/ Net consumptive use is the amount of water, excluding effective precipitation, used in evapotranspiration.

3/ Estimates of water depletion resulting from riparian vegetation and nonbeneficial phreatophytes may in some instances include consumptive water use due to natural conditions that are impossible to separately identify and differentiate from man-related development.

4/ Water yield data is for the 1943-60 period and does not represent a forecast of future annual yields.

5/ Discharge data for the periods 1980, 2000, and 2020 are based on 1943-60 yields and are not a forecast of future annual discharges.

Source: Developed by USDA Field Party

Export

Out-of-basin exports will account for 289,900 acre-feet (67 percent) of the total water depletion in the basin by 2020. Two potential developments discussed in Chapter VIII are the USBR Dolores Project and the Montezuma Valley Irrigation Company PL 566 project. They will export 126,900 acre-feet and 16,000 acre-feet respectively (Project Location Map, following page IX-5). The Dolores Project should be operational by 1980 and will deliver water to the San Juan River Basin for irrigation, municipal, and industrial uses. The Dolores Project, together with the expected full use of existing water rights will increase the export of 273,900 acre-feet by 1980.

Irrigated Crops

Consumptive use by irrigated crops is expected to increase 41,400 acre-feet between the 1943-60 period and 2020. This increase (88 percent) is due to the development of new irrigated land (over 26,000 acres) resulting from the proposed USBR San Miguel Project discussed in Chapter VII, that is expected to be operational by 2000. The same consumptive irrigation requirement (CIR) factors, developed for the water use inventory, were used to estimate the net consumptive use 9/ by crops for the projected irrigated acreages. Crop distribution and projected acreages were developed using all available information for proposed developments.

Other Uses

Other uses, including those by industry, livestock, phreatophytes, people (municipal and domestic), and reservoir evaporation losses, will total 49,500 acre-feet by 2020 (an eightfold increase). Industrial water use alone will increase to 23,300 acre-feet by 2020 due to a new coal-fired electric generating plant proposed at Naturita and development of potash deposits in Gypsum Valley. These two uses will account for 20,000 acre-feet (86 percent) of the industrial uses in 2020.

Increases in consumptive use of water by people, nonbeneficial phreatophytes, livestock, evaporation losses, and other minor uses were estimated and are indicated on Table 13. These estimates were based on projected increases between 1943-60 and 2020 using the factors developed for the water use inventory.

9/ Net consumptive use on irrigated land is the amount of water, exclusing effective precipitation,used in evapotranspiration by a crop during its growing season.

Recreation Resources

Natural Features

Natural features of the recreation resource include parts of the San Juan, Grand Mesa, Manti-La Sal, and Uncompahgre National Forests which have lake, reservoir, river, forest, mountain, biological, and geological attractions. All are natural environment areas. They have day, weekend, vacation, and tourist enroute use. Recreation activities include boating, camping, driving for pleasure, fishing, hiking and mountain climbing, horseback riding, hunting, nature walks, picnics, ice skating, sledding or tobogganing, snow mobiling, and snow skiing. In addition, it is estimated that 17 miles of the Dolores River are suitable for canoe trails.

The Wilson Mountains Primitive Area is administered as a special zone under Forest Service regulations. (Location of recreation areas are shown on the Transportation and Recreation Area Map following page IV-12).

Wildlife

Wildlife varies according to available habitat. Mountains provide food, water, and cover important to elk, deer, mountain sheep, bear, mountain lion, eagles, sharptail and blue grouse, ptarmigan, snowshoe hare, beaver, muskrat, mink, martin, weasel, skunk, badger, raccoon, bobcats, turkeys, waterfowl, and others.

Foothills, canyons, desert areas, and cropland provide food and cover for deer, antelope, sage grouse, chukar partridge, pheasant, quail, dove, jackrabbits, cottontail rabbits, coyotes, waterfowl, and songbirds.

Water Based Recreation

Fishing is the most important water based recreation activity, and the majority of the streams and lakes of the basin are stocked with trout. Principal stocked trout are rainbows. There are lakes and streams with native (cutthroat), brook, and brown trout. These fish are also planted by the Colorado Division of Game, Fish and Parks. There are some catfish at and near the mouth of the Dolores River.

Private water based recreation at Trout Lake

Boating is primarily in conjunction with fishing. Few of the lakes are large or warm enough for water skiing. Establishment of canoe trails may add to the interest of water based recreation.

There is a municipal swimming pool at Uravan and it is a very popular recreation facility in the summer months. Dunton has a hot water spring (spa) type of swimming pool which gets limited use.

Winter Sports

The Stoner ski area at Stoner, Colorado, and the Dallas ski area on Colorado Highway 62 at the northeast side of the basin are the principal winter sport areas. They are generally operated as weekend use areas.

Ice skating, sledding, and snowmobiling are other winter sports of the area. Available resources are ample for expansion of these activities.

IV. ECONOMIC DEVELOPMENT

Historical Development 1/

Exploration

The first recorded visit of a white man into the Dolores River Basin was a Spanish explorer by the name of Don Juan Maria de Rivera. In 1765, Governor Cauchupin of New Mexico, then a part of Spanish territory, sent Rivera to explore the unknown lands to the north. He and his group of New Mexicans entered southwestern Colorado near Pagosa Springs. Turning westward they made their way to the Dolores River which they followed northwestward to the Paradox Valley. The Spaniards left the Dolores River Basin by crossing the Uncompahgre Plateau to the east and entering the Gunnison Basin. Rivera and his hardy followers reached the Uncompahgre River and followed it to its junction with the Gunnison River at the present site of Delta. This was as far north as Rivera came. He returned to New Mexico to report on his journey through the unknown wilderness.

Eleven years later in 1776 two Spanish priests, Fathers Dominguez and Escalante, with 12 companions started out from Santa Fe, New Mexico, to find an inland route from that city to Spanish missions in California. The party followed the same general route of Rivera through the Dolores River Basin. From the vicinity of Montrose the expedition passed near Hotchkiss, Collbran, and Rangely before entering Utah. They reached Utah Lake before heading south to the Utah-Arizona border where they planned their return to Santa Fe. According to Escalante's diary the party failed to reach their California destination because of ensuing winter weather.

Concurrent settlement began in 1877 at four locations in the Dolores River Basin. Paradox Valley in western Montrose County and the Dolores River Valley in Montezuma County were settled primarily for farming and ranching. Mining for gold was the primary motive in establishing the mining boom towns of Telluride and Placerville, both in eastern San Miguel County.

1/ This entire section draws heavily upon Uncompahgre Country by Wilson Rockwell and A History of Montezuma County by Ira S. Freeman.

Agricultural Settlement

In the early settlement of the Dolores River Valley the homeseeker, with a few head of livestock, preempted land along the river. As herds grew in number, cattle, and later sheep, rapidly became the leading industry and main property asset. In many instances the herds were larger than the range could support and this resulted in overgrazing that created land resource use problems.

In addition to the Paradox Valley the communities of Naturita, Nucla, Redvale, and Norwood were exploited early for their agricultural capability. Early settlement was adjacent to the San Miguel River where water was diverted to irrigate cultivated fields of vegetables, fruit, and alfalfa. Remoteness from a railroad and market made it impractical to sell vegetables and fruit commercially. Consequently, production of cattle became the primary source of income. Cattle were driven to the railheads at Montrose or Placerville on the hoof and shipped to the central markets.

The real lifeblood of early agricultural development in the basin was water. This is still true today as a number of large reservoirs have been constructed to irrigate land for agricultural purposes. To supplement the limited supply of water in the Paradox Valley, the first irrigation ditch was constructed in 1884 by the Steele and Stevens Cattle Company. Later, in 1895, a hardy group of colonists, organized in Denver by the Colorado Cooperative Company, arrived in the vicinity of Nucla to settle and to construct an irrigation ditch. The following year they established the town of Pinon,[2/] which served as headquarters camp of their cooperative ditch enterprise. As soon as the ditch was finished in 1904, members of the colony left Pinon and preempted claims on Tabeguache Park. Only a small cemetery remains at the site of the original settlement of Pinon.

The earliest recorded water impoundment, Gurley Reservoir, was constructed in 1893 by Gurley and Wheeler. A ditch was dug from this dam through Beaver Park to Wright's Mesa by the Gurley Ditch Company. As additional land was developed, more storage was needed and an enlargement of the reservoir and ditch was initiated in 1910. When the company became insolvent about 1915, the Farmers Water Development Company was formed. They completed the enlargement and have subsequently managed the water supplies of the reservoir. A second enlargement was completed in 1948, followed by a third enlargement in 1962. Plans were proposed in 1968 for a fourth enlargement to the Gurley Reservoir.

[2/] Pinon was located at the confluence of Cottonwood Creek and the San Miguel River, approximately 10 miles northeast of Naturita.

The Cone Reservoir and Ditch were built around the turn of the century by local Norwood ranchers and farmers to supplement the supply of irrigation water to Wright's Mesa from the Gurley Reservoir. In the Paradox Valley the biggest water development was construction of the Buckeye Reservoir. Although construction started in 1911, it was 10 years later when the project was finally completed.

Mining Exploits

Mining activity played an important part in the early history of the Dolores River Basin. Gold discoveries enticed early settlers to Placerville and Telluride. Other valuable ores mined included silver, lead, zinc, and copper.

Gold is present in the sand and gravel bars of the Dolores and San Miguel Rivers, but for the most part it is so scattered above the water level of these streams that it has not been practical to bring water for sluicing it.

During the 1880's good, coarse gold was placer mined by hydraulic pressures in the vicinity of Placerville. When the Rio Grande Southern Railroad reached Placerville from Ridgway in 1890, the town became the shipping center for products from the growing agriculture and mining economy of the Paradox Valley and San Miguel Basin. After World War II the mining industry increasingly relied upon trucks to haul the ore, thereby eliminating most of the rail transport business. In 1951 the Rio Grande Southern Railroad stopped operations. However, in the last few years of operation, the railroad's management improvised a special railcar in an attempt to rejuvenate its slumping business. The innovation, half automobile and half train, accomodated six to eight passengers and up to five tons of freight. This unique contraption, commonly known as the Galloping Goose, consisted of a boxcar grafted to a Pierce Arrow sedan.

Sporadic mining booms of strategic minerals of radium, uranium, and vanadium share in the interesting historical development of the Dolores River Basin. Carnotite, a radioactive ore containing these elements, was first mined in the basin in the 1880's for the small amounts of gold found in it. After the Smithsonian Institute discovered that carnotite contained uranium, several tons were shipped to France in 1898 where Madame Curie extracted radium from the ore. The discovery and subsequent identification of the ore brought a flood of prospectors into the Paradox Valley. Although a great many deposits were located, the demand for carnotite was minimal because the only known uses for it were in photography, china painting, and experimentation in foreign chemical laboratories.

Remains of an era of transportation, The Galloping Goose, Rio Grande Southern Railroad

A flurry of uranium mining activity began in 1910 when the General Vanadium Company established a field headquarters in western San Miguel County. Among the largest consumers of carnotite in 1912 were the manufacturers of Westclox luminous dials. In this process radium was applied to dials of clocks for illumination. About this same time Vanadium Corporation of America entered the field as extensive processors of vanadium used as an alloy for hardening steel. They built a 60-ton mill at Naturita. When the federal government created the National Radium Institute a few years later, the demand for radium increased greatly. Reduction plants were set up in the vicinity of Naturita. Ore containing uranium oxide brought $80 a ton at Placerville, the nearest railhead. This boom was fostered by extensive research in radium therapy for a potential cure for cancer. Between 1898 and 1928 ore taken from the basin accounted for almost half the world's production of radium.

A third mining impetus was initiated in 1938 when a rival company, the United States Vanadium Corporation, constructed a model town and mill 15 miles down the San Miguel River from Naturita.[3/] The new community was called Uravan, a combination of the first syllables of uranium and vanadium. The population of Uravan jumped to 750, and a school and hotel were soon in operation. During 1938 the production of uranium oxide concentrate at the Uravan plant averaged 250 tons a day. The company's monthly payroll ran between $50,000 and $60,000.

3/ In 1953 the Union Carbide Corporation purchased this plant and its entire operation.

Union Carbide Corporation, uranium concentration plant, Uravan

During World War II the United States was actively engaged in nuclear energy research. This greatly accelerated uranium production at the mines and mills in the basin. However, the production of uranium and vanadium reached an all-time high in the late 1950's and early 1960's. This unprecedented boom increased the population of Uravan to over 1,000 and stimulated the basin's overall economy as well.

General Description

Population -- Characteristics, Trends, and Projections

From 1920 to 1960 the population of the Dolores River Basin has increased 2,551. Significant population gains were evident in the 1930-40 decade and in the 1950-60 decade. However, during the 1920's and 1940's a noticeable decline occurred. Over this same period of time (1920-1960) Colorado's population increased 87 percent while that of the Nation grew 69 percent. Similar growth changes were recorded for towns. The proportion of population shifted from rural areas to towns in the following manner:

Dolores River Basin	5 percent
Colorado	20 percent
United States	13 percent

(Table 14 shows area, population, and density by counties for the Dolores River Basin). Although one-fourth of the basin's land lies in San Miguel County, over half of its population resides in Montrose County. On a population density basis Montrose County ranks first with 5.0 persons per square mile, while four other counties have a density factor of less than one person per square mile. Actually, the Dolores River Basin is quite sparsely populated (2.3 persons per square mile) when compared to the state (16.9) and to the Nation (50.5). Approximately 84 percent of the basin's residents are classified as rural nonfarm. This classification includes residents of the basin towns because none of the towns exceed 2,500 population. Many of these rural nonfarm residents can be considered part-time farm and seasonal farm but normally accrue less than $250 annually from farm product sales. The balance (16 percent) of the basin's population is rural farm.

Table 14.--Population, area, and density by counties, Dolores River Basin in Colorado and Utah, 1960

County	Population: Rural nonfarm	Population: Rural farm	1960 population	Area (Sq.Mi.)	Density per square mile
Dolores	347	55	402	804	0.5
Mesa	169	84	253	525	0.5
Montezuma	1,438	160	1,598	408	3.9
Montrose	4,524	951	5,475	1,105	5.0
San Miguel	2,314	380	2,694	1,251	2.2
Total - Colorado 1/	8,792	1,630	10,422	4,093	2.5
Grand	112	16	128	255	0.5
San Juan	161	45	206	297	0.7
Total - Utah	273	61	334	552	0.6
Total - Basin	9,065	1,691	10,756	4,645	2.3 2/

1/ Although 1,400 acres are in Ouray County, there are no inhabitants of that county residing within the basin.

2/ Mean density of the basin.

Source: U. S. Bureau of Census

A comparison of the basin's population changes over time indicates that only one county (Montezuma) gained population consistently. Table 15 also reveals that the basin's population of four other counties increased during the 1920-60 period. The remaining two counties, Dolores and San Miguel, declined by an aggregate margin of 42 percent. A distinct drop in total basin population was apparent during the 1920's and again in the 1940's. Likewise, the population of basin towns registered declines for the decennial census years of 1930 and 1950, but over the forty-year period, 1920-60, an increase of 73 percent for towns occurred (Table 16).

Table 15.--Population by counties in the Dolores River Basin, Colorado and Utah, 1920-60

County	Year				
	1920	1930	1940	1950	1960
Dolores	481	597	548	258	402
Mesa	196	156	193	220	253
Montezuma	877	931	1,276	1,423	1,598
Montrose	1,608	1,244	2,732	2,794	5,475
San Miguel	4,862	2,023	3,352	2,395	2,694
Total - Colorado	8,024	4,951	8,101	7,090	10,422
Grand	37	55	87	32	128
San Juan	144	106	109	113	206
Total - Utah	181	161	196	145	334
Total - Basin	8,205	5,112	8,297	7,235	10,756

Source: U. S. Bureau of the Census

Table 16.--Population of towns, Dolores River Basin in Colorado, 1920-60

Town	County	Year				
		1920	1930	1940	1950	1960
Dolores	Montezuma	465	557	804	729	805
Naturita	Montrose	-	-	-	-	979
Norwood	San Miguel	365	229	412	294	443
Nucla	Montrose	217	221	361	457	906
Rico	Dolores	326	447	388	212	353
Telluride	San Miguel	1,618	512	1,337	1,101	677
Uravan	Montrose	-	-	-	-	1,005
Total		2,991	1,966	3,302	2,793	5,168

Source: U. S. Bureau of the Census

The average size family in the basin is about four people (Table 17). Age distribution is grouped into three classes: under 18, 18-65, and 65 and over. Fifty-one percent of the basin's residents are in the 18-65 category while 41 percent are under 18 years. This leaves 8 percent for the 65 and over group.

Table 17.--Number of families and age distribution by counties, Dolores River Basin in Colorado and Utah, 1960

County	Total population in basin	Number of families in basin	Age distribution		
			Under 18	18-65	65 and over
Dolores	402	94	172	209	21
Mesa	253	65	96	132	25
Montezuma	1,598	404	676	811	111
Montrose	5,475	1,413	2,202	2,755	518
San Miguel	2,694	693	1,068	1,475	151
Total - Colorado	10,422	2,669	4,214	5,382	826
Grand	128	31	56	68	4
San Juan	206	43	104	95	7
Total - Utah	334	74	160	163	11
Total - Basin	10,756	2,743	4,374	5,545	837

Note: Average size family in basin = 3.92 people.

Source: U. S. Bureau of the Census

Selected socio-economic characteristics for the basin are presented below. The various items were taken as county median values from the U. S. Bureau of the Census publication, "1960 Characteristics of the Population, Colorado." In order to adjust the county median values to a basin average, a direct proportion was based upon the number of basin residents per county. Estimates from these computations for 1960 show:

--Median family income was $4,960
--Median age was 25.2 years
--Median school years completed was 11.0 years
--Seven percent completed one or more years of college
--$251 was the average local government revenue per capita

In 1960 the per capita income for the basin was $1,265. This is low compared to the State of Colorado ($2,275) and to the Nation ($2,215).

As evidenced from Table 15, population changes were not uniform from 1920 to 1960. Therefore, a linear regression equation was derived to estimate the population for 1980, 2000, and 2020.[4/] This procedure bases projections on past trends without regard to natural resources reserves or other dependent factors for economic growth and development. Table 18 shows the basin's population projections.

Table 18.--Estimated population, Dolores River Basin in Colorado and Utah, 1980-2020

Year	Population
1980	10,800
2000	12,300
2020	13,700

Source: Derived by regression analysis from U. S. Bureau of Census data.

Major Types of Economic Activity

In order to understand the economy of a given locale it is essential to know what the basic (primary) industries are and to what degree the resident population is supported by them. Normally the primary industries are oriented to the natural resources of the basin and thus, form the nucleus or base for secondary activities. Table 19 illustrates this point quite clearly for the Dolores River Basin. Approximately one-third of the civilian work force is engaged in mining, the most important industry in the basin. Agriculture is the source of employment for an estimated 625 people, or about 18 percent of the labor force. This represents a decline of approximately 12 percent since 1950 when about 30 percent of the basin's labor force was engaged in farming. Manufacturing, accounting for 2 percent of work population, consists of production of primary metals; food and kindred products; and chemicals and allied products. Approximately 100 people (3 percent) are earning wages from forest product industries. Collectively, the primary industries comprise 56 percent of the basin's labor force. This fact emphasizes the importance of natural resources to the basin's economy.

4/ The linear regression equation fitted to census data is Y = 5753.5 + 722.5X, where Y is the predicted value and X is a 10-year interval beginning at 1920. Hence, the 1920 value is 5753.5 + 722.5 (1) = 6476; the 1930 value is 5753.5 + 722.5 (2) = 7198.5; etc.

Table 19.--Occupation of employed, Dolores River Basin in Colorado and Utah, 1967

Industry group	Estimated employment	Distribution
	Number	Percent
Primary activities		
Agriculture	625	17.5
Forestry	100	2.8
Manufacturing	80	2.2
Mining	1,200	33.6
Subtotal	2,005	56.1
Secondary activities		
Construction	90	2.5
Services	910	25.5
Trade and sales	420	11.7
Subtotal	1,420	39.7
Total employed	3,425	95.8
Unemployed	150	4.2
Total labor force	3,575	100.0

Source: Colorado Department of Employment, U. S. Bureau of the Census

Secondary industries supply about 40 percent of the labor force with employment. The largest activity of this group (services) provides employment for 910 people; this segment (over 25 percent of the labor force) includes government, education, finance, insurance, real estate, transportation, communication, and public utility workers. Nearly 12 percent of the basin's work force are employed in trade and sales while over two percent are construction workers. About four percent are classified as unemployed.

Mining operation for primary minerals, Telluride

Another cross-sectional view of the basin's employment situation is shown in Table 20. The 1960 census data were adjusted to show recent trends (1967) in the basin's employment by source of income for selected worker classes. These estimates indicate that over 60 percent of the labor force are employed by private industry. About 24 percent are self-employed; federal, state and local governments employ 14 percent; and, unpaid family labor accounts for the remaining 2 percent.

Table 20.--Employment by class of worker, Dolores River Basin in Colorado and Utah, 1967

Source	Estimated employment	Distribution
	Number	Percent
Private wage and salary	2,075	60.6
Self-employed	810	23.6
Government	480	14.0
Unpaid (family)	60	1.8
Total	3,425	100.0

Source: U. S. Bureau of Census

Transportation System

The Dolores River Basin is relatively isolated from the main flow of national highway, rail, and air traffic. There are no railroads or commercial airlines serving the basin. Major existing highways are two-laned, paved state roads. Approximately 309 miles of these principal avenues of travel are confined to the major drainage patterns which flow northwesterly through the basin. In addition, there are about 15 miles of surface-treated roads, 255 miles of gravel roads, and several hundred miles of unimproved dirt roads. Most of these secondary roads run north-east-southwest and intertie with the state routes (see Transportation and Recreation Area Map following page IV- 12).

Agriculture and Related Economic Activity

Livestock economy on irrigated land, La Sal, Utah

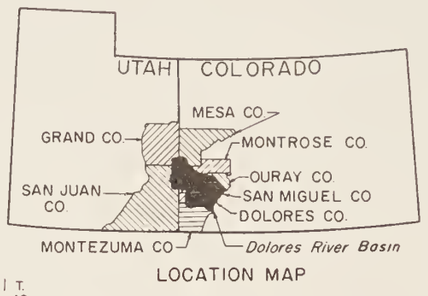
TRANSPORTATION & RECREATION AREA MAP

DOLORES RIVER BASIN

COLORADO and UTAH

JULY 1968

SCALE IN MILES 4 0 4 8



LOCATION MAP

RECREATION AREAS

- Camp and Picnic Area
- Camp and Picnic Area, Proposed
- Winter Sports Area
- Resort and Dude Area
- Primitive Area
- Water Recreation Area
- Water Recreation Area, Proposed

LEGEND

- CITIES AND TOWNS
- RESERVOIR
- COUNTY LINE
- STATE LINE
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- NATIONAL FOREST, PRIMITIVE AREAS
- HIGHWAY, HARD SURFACED
- IMPROVED ROAD
- U.S. HIGHWAY
- STATE HIGHWAY
- NATL. FOREST ROUTE

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

4070-4

GPO 832-010

Like most of Colorado's western slope river basins, livestock production is the major agricultural pursuit in the Dolores River Basin. In terms of value of all farm products sold, livestock and livestock products accounted for about 90 percent of the total basin's output in 1964. Accordingly, the major portion of all crop production is for livestock feed. Of the total cropland harvested in 1964, 75 percent was irrigated, and over 85 percent of all basin farms and ranches had some irrigated land.

The Resource Base

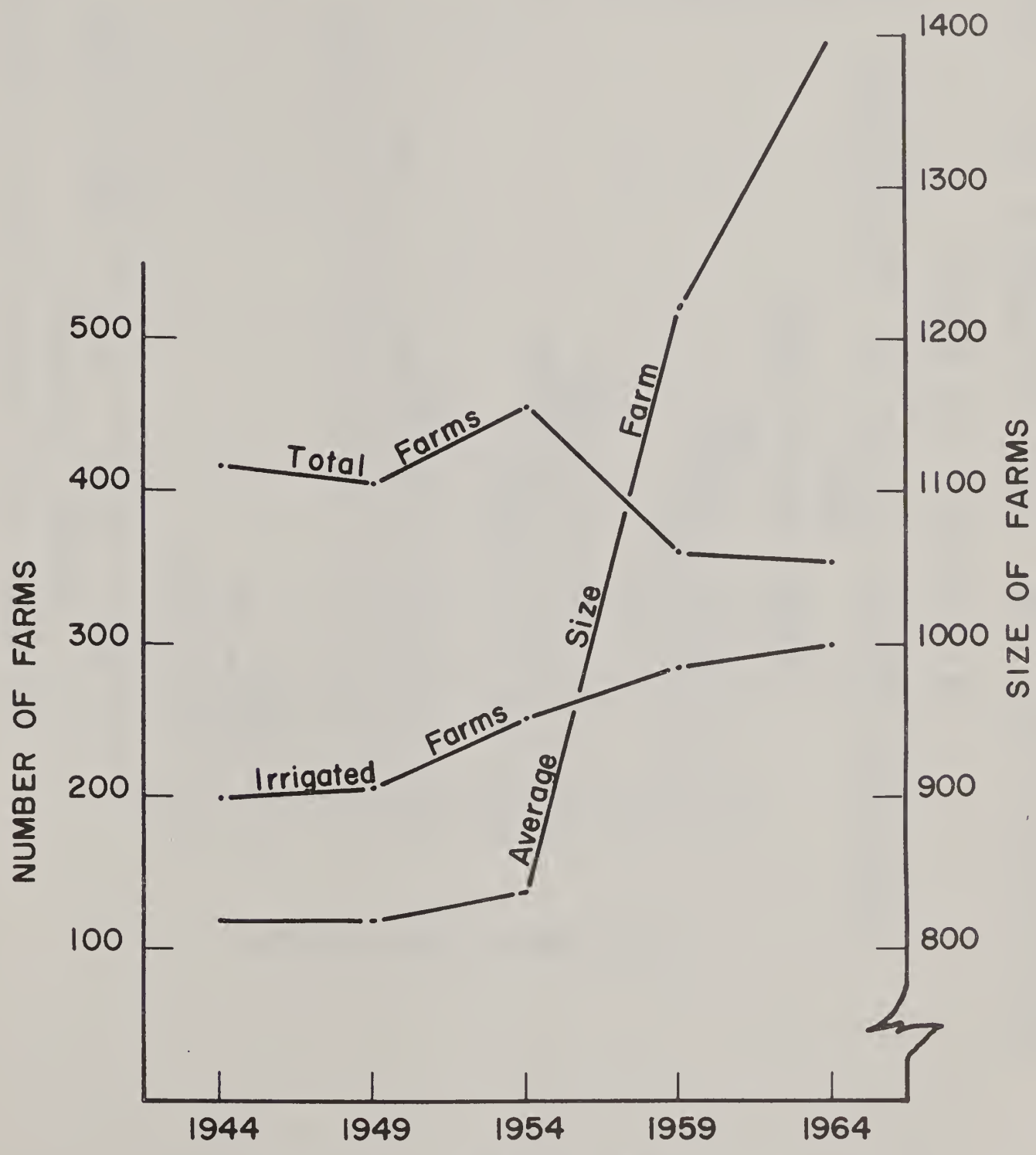
Number and Size of Farms and Ranches

Significant agricultural changes have occurred in the Dolores River Basin during the last 20 years. While the number of farms has been gradually declining, the number of farms with some irrigated land has increased by 101 (51 percent). The amount of land in farms and ranches has increased from 342,019 acres in 1944 to 498,254 acres in 1964, a gain of 156,235 or 46 percent. The average size of farms and ranches has grown from 820 acres to 1,400 acres (Figure 1).

Figure 2 graphically shows the changes that have taken place with respect to farm size. Number of farms and ranches declined from 417 units in 1944 to 346 units in 1964 for a loss of 61 farms (15 percent). Reduction in the number of farms occurred in the two smaller size categories, under 50 acres and 50-499 acres. Notable gains of 65 percent (500-999 acres category) and 108 percent (1,000 acres and over category) are cited for the two larger groupings. This trend emulates the national one -- as agriculture becomes more capital intensive, fixed costs per unit produced are high unless volume in animals and acreage is large. Therefore, the economic trend is toward larger farm and ranch units.

On the basis of income level, 76 percent of the farms in 1964 were classed as commercial and 24 percent noncommercial (Table 21). Approximately 10 percent of the commercial farms had incomes of less than $2,500 in 1964. This income category ($50-2,499) experienced a significant drop in the number of farm units. At the same time the number of part-time farms increased nearly threefold. Part-time farms, those earning less than $2,500 per year, are distinguished from the "marginal" commercial farms in that the farm operator either worked off the farm more than 100 days or had nonfarm income greater than farm income. Generally, farms with less than $2,500 income are characterized by small acreages, poor land capability class, and/or yielding low value crops and pasture.

THE NUMBER AND SIZE OF FARMS
DOLORES RIVER BASIN
IN
COLORADO AND UTAH, 1944-1964

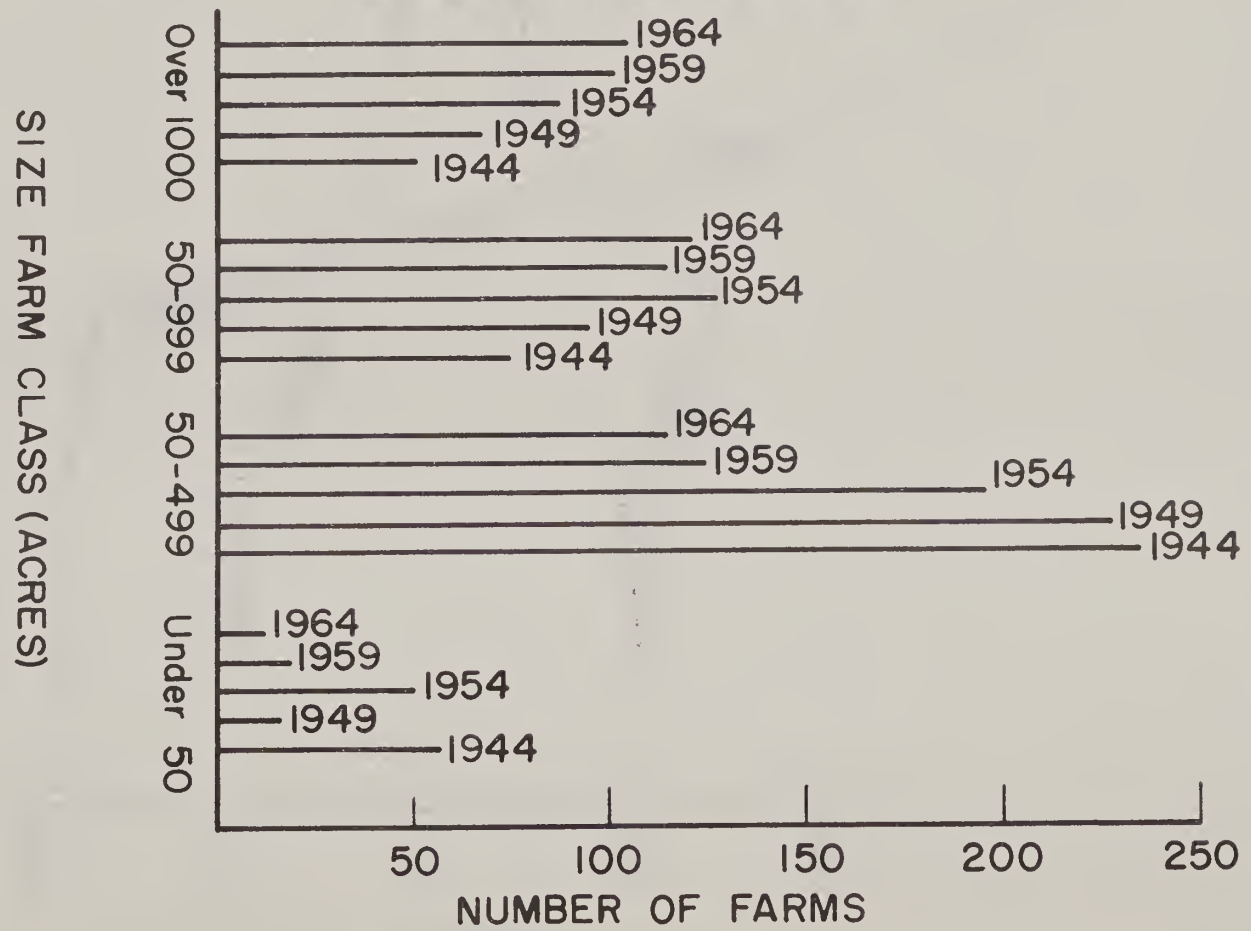


Source: U.S. Bureau of Census–Census of Agriculture

Figure No. 1

DISTRIBUTION OF THE NUMBER OF FARMS BY SIZE CLASS

DOLORES RIVER BASIN IN COLORADO AND UTAH 1944-1964



Source: U.S. Bureau of Census-Census of Agriculture

Figure No.2

Table 21.--Farm classification by economic class, Dolores River Basin in Colorado and Utah, 1949-1964

Item	1949	1954	1959	1964
	Number	Number	Number	Number
Classification of farms by economic class:				
Commercial farms				
Value of farm products sold:				
$10,000 or more	104	110	85	108
$2,500 to $9,999	158	183	141	138
$50 to $2,499 1/	106	93	43	26
Other farms				
Part-time	19	24	83	60
Part-retirement or residential	19	46	9	24
Total	406	456	361	356

1/ Provided the farm operator was under 65 years of age and did not work off the farm 100 or more days per year.

Source: U. S. Bureau of Census - Census of Agriculture (1949-64)

Two points are made relative to Table 22. First, the total farm operators working off their farms is more than double the number working off farm 100 days or more (exception: 1959), and secondly, 1959 -- a year of minor economic recession -- apparently affected the basin's agricultural economy as a disproportionate number of farm operators sought work other than farm to supplement their incomes.

Table 22.--Number of farm operators with off-farm employment, Dolores River Basin, Colorado, 1944-64

Year	Farm operators working off their farms, total	Percent of total operators	Farm operators working off farm 100 days or more	Percent of total operators
1944	163	41	80	20
1949	149	38	74	19
1954	206	47	76	17
1959	189	55	116	34
1964	115	34	47	14

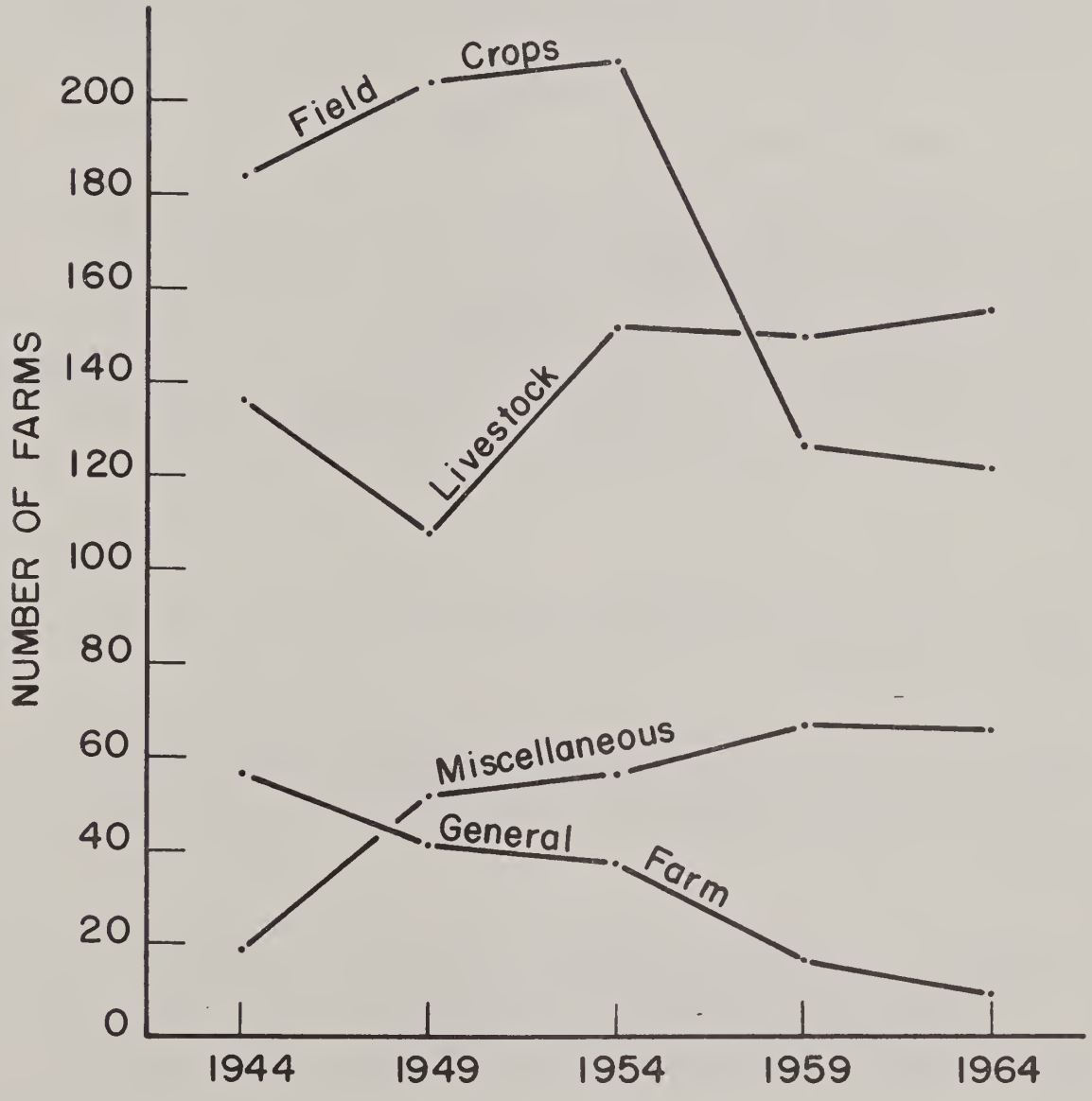
Source: U. S. Bureau of Census - Census of Agriculture

Types of Farms and Ranches

From Figure 3 the following distinct trends are evident: (1) livestock production is now the predominant activity replacing the once-dominant field crops, and (2) the number of general farms has noticeably declined to ten while those farm units classed as miscellaneous have more than tripled.5/ During the 21-year period, 1944-64, farms classed as field crops dropped nearly three per year, and those farm units typed as livestock gained about one per year. The miscellaneous farms category has stabilized and should not expand much in the future. The number of general farms has decreased from 57 units in 1944 to 10 in 1964. Livestock-type farms have been relatively stable since 1954, livestock production is expected to show modest gains in comparison to other types of farms because the resources of the basin are oriented to extensive operations.

5/ U. S. Bureau of Census - Census of Agriculture definitions: general farm - field seed crops, hay, grass, and silage. A farm was also classified as general if it had cash income from three or more sources and did not meet the criteria for any other type. Miscellaneous farm - nursery and greenhouse products, forest products, mules, horses, colts, ponies, furbearing animals, bees, honey, goat milk, and farms with no value of farm products sold. Also, all institutional farms and Indian reservations.

TYPE FARMS BY NUMBER
DOLORES RIVER BASIN
IN
COLORADO AND UTAH, 1944-1964



Source: U. S. Bureau of Census—Census of Agriculture

Figure No. 3

Value of Land and Buildings

In 1964 the total investment on privately-owned farms for land and buildings was approximately $21.7 million (Table 23). Over the 21-year period this represents a gain of $18.1 million or about a sixfold increase. In terms of value per farm, the rate of growth has been rather constant since 1944, although the 1964 average value per farm did not show as large a gain as the previous census year. On a per acre basis the value of land and buildings has quadrupled from 1944 to 1964. These monetary shifts to higher incremental averages can be attributed in part to the increase in the average size farm operating unit as well as the inflationary trends of increasing price levels. By comparison with other western slope Colorado River basins, the Dolores River Basin ranked third ($58,147) in value of land and buildings per farm in 1959. 6/ The White River Basin was first with a $75,000 value per farm. Next was the Yampa River Basin with $69,552. The Gunnison and Colorado (Main Stem) River Basins rated fourth and fifth, $49,187 and $43,000, respectively.

Farm and Ranch Tenure

Since 1944 farm operators classed as full owners have continually declined from 247 to the present estimate of 157. Meanwhile, part owners have grown about 51 percent for an annual mean growth rate of three for the last twenty years. Tenant farmers dropped from 58 to 31 (Figure 4). In 1964, 47 percent and 44 percent of the farmers and ranchers were part-owners and owner-operators. The percent of tenant farmers in the basin has remained nearly constant (at 10 percent) for the last twenty years. For Colorado, the 1964 proportion of tenancy was 18 percent, nearly double the percent for the Dolores River Basin.

Markets and Marketing

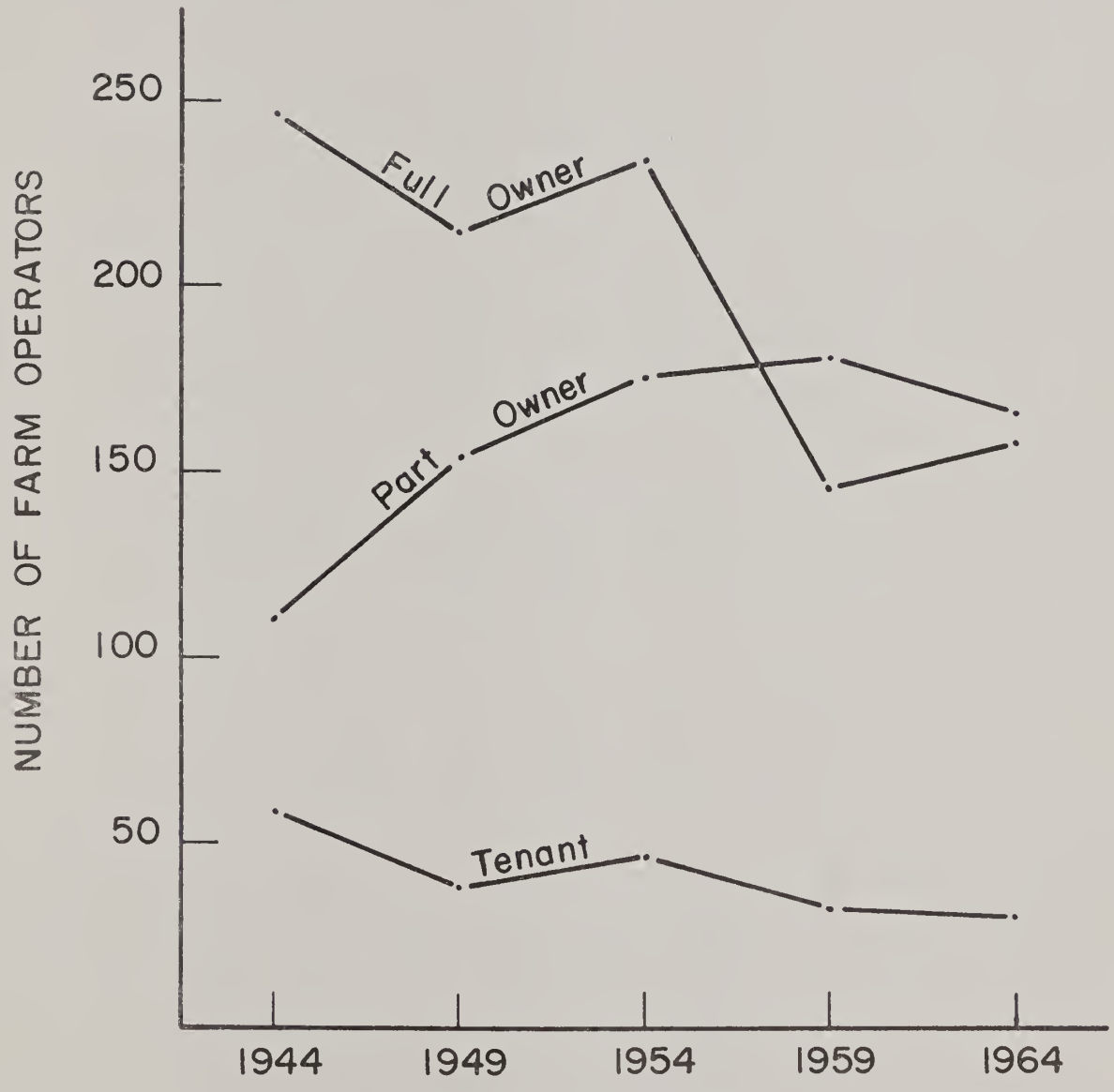
The major agricultural exports are livestock and barley. A limited amount of hay is also exported to the San Juan River Basin for winter feeding of livestock.

The basic practice of open range cow-calf operations determines the common livestock production and marketing patterns. Most of the sales of young beef animals are in the fall as feeder calves, with some being held through the winter and sold the following year as yearling feeders.

6/ This comparison includes five of the six major drainages of the Colorado River in Colorado; no estimates have been computed for the San Juan River Basin at this time.

NUMBER OF FARM OPERATORS BY TENURE

DOLORES RIVER BASIN IN COLORADO AND UTAH, 1944-1964



Source: U.S. Bureau of Census–Census of Agriculture

Figure No. 4

Table 23.--Value of land and buildings, Dolores River Basin in Colorado and Utah, 1944-1964

Item	Unit	1944	1949	1954	1959	1964
Total farms	Number	417	406	456	361	356
Land in farms and ranches	Acres	342,019	333,036	382,533	440,843	498,254
Total value of land and buildings	Dollars	3,586,083	9,726,299	20,291,067	20,991,121	21,722,974
Value of land and buildings per farm	Dollars	8,600	23,956	44,498	58,147	61,020
Value of land and buildings per acre	Dollars	10.49	29.21	53.04	47.62	43.60

Source: U. S. Bureau of Census - Census of Agriculture

A large portion of calves goes east for wheat pasture grazing. Some feeders also go west and south to feedlots in other states. Feeder cattle are sold by the direct method or through Colorado auctions. The cull cows that are sold move both west and east for slaughter.

Nearly all lambs produced go directly to packers in Denver and California. All livestock are transported from the basin by truck. Approximately 610,000 pounds of wool are produced annually. For the most part, it is high quality, fine-textured wool that is prized in garment manufacturing. About two-thirds of the wool production is purchased by a Salt Lake City wholesaler; the balance is placed in a Montrose warehouse for intermediate storage prior to shipment to eastern-based firms.

The Mountain Packing Company at Dolores processes approximately 1,000 animals a year in addition to 500 to 700 big game animals (deer and elk). Another small packing plant (estimated volume of 250 animals plus big game) is located in Norwood and does custom slaughtering for local residents.

Nearly all the barley harvested is malting barley sold to the Adolph Coors Company. The grain is transported by truck to Delta where the Coors Company maintains a large granary. From there the barley is shipped via Rio Grande Railroad to the Golden, Colorado, brewery.

Agricultural Production

Cropland acreage in the Dolores River Basin has been stable for the past 25 years. However, grain acreages, principally corn, winter wheat, and barley, have dropped off while acreages in hay have increased. Along with this change there has been a 60 percent increase in the size of the average farm/ranch, more land under intensive irrigation, and higher crop yields as a result of technological efficiencies. This trend indicates that livestock ranchers have a comparative economic advantage over field crop and general farm operations.

Irrigated and Dryland Crops

Total harvested cropland declined from 24,859 acres during the 1943-60 study period to 24,215 acres in 1965 while irrigated cropland increased from 14,163 acres to 17,966 acres over the same period (Table 24). Accompanying this trend is the increasing importance of livestock enterprises.

Presently, hay of all kinds accounts for over 60 percent of cropland harvested; but during the 1943-60 period hay production averaged 45 percent of the total harvested cropland. Also, a greater proportion (93 percent) of hay is now irrigated than was during the 1943-60 time span (72 percent). The current production of hay is on approximately 14,600 acres. Of this total amount, about 11,000 acres or 75 percent is in alfalfa hay. However, this percent is down somewhat from the 1943-60 average of 81 percent (9,000 acres in alfalfa hay compared to 11,200 total hay acres). The basin currently produces about 28,800 tons of hay per year with an average value of about $716,000. The 1943-60 average yield of all hay grown was 1.87 tons per acre. When compared with the current yield rate of 1.97 tons per acre, a slight increase (something in the order of 200 pounds or 3 more bales of hay per acre) can be recognized.

Irrigated cropland, West Paradox Watershed
(soil mapping unit 2)

Cropland pasture averaged about 17,400 acres, or 26 percent of the total cropland acreage, during the 1943-60 period, but it has significantly increased to 35 percent for present conditions. Irrigated pasture averaged almost 11,200 acres for the 1943-60 period, but the 1965 estimate, to reflect the current situation, has ascended to approximately 17,300 acres. Again, this trend indicates a more intensive use of water and cropland for livestock feed operations. Also, a

Table 24.--Average acreage, total production and gross value of principal irrigated and dry farm crops harvested, Dolores River Basin in Colorado and Utsh, 1943-60 and 1965

Crop	Unit	1943-60 Average			1965		
		Irrigated lsnd	Dry farmland	Total	Irrigated land	Dry farmland	Total
Corn							
Harvested	Acres	1,880	216	2,096	1,448	32	1,480
Production	Bu. 1/	88,360	3,456	91,816	100,065	951	101,016
Value	Dol.			124,870			127,280
Winter wheat							
Harvested	Acres	548	3,428	3,976	795	1,897	2,692
Production	Bu.	16,440	44,564	61,004	23,432	19,362	42,794
Value	Dol.			111,028			56,915
Spring wheat							
Harvested	Acres	326	144	470	75	0	75
Production	Bu.	8,802	2,016	10,818	3,193	0	3,193
Value	Dol.			19,148			4,119
Oats							
Harvested	Acres	762	169	931	879	119	998
Production	Bu.	30,480	4,901	35,381	39,221	1,880	41,101
Value	Dol.			27,597			30,414
Barley							
Harvested	Acres	1,612	524	2,136	956	388	1,344
Production	Bu.	66,092	9,956	76,048	51,926	8,313	60,239
Value	Dol.			76,048			63,853
Rye							
Harvested	Acres	0	23	23	np 2/	np	np
Production	Bu.	0	253	253			
Value	Dol			271			
Potstoes							
Harvested	Acres	405	41	446	74	2	76
Production	Cwt.	42,120	1,968	44,088	11,693	255	11,948
Value	Dol.			67,455			20,670
Beans (Dry)							
Harvested	Acres	338	2,977	3,315	110	2,715	2,825
Production	Cwt.	3,566	9,556	13,122	791	6,531	7,322
Value	Dol.			85,555			55,647
Alfalfa 3/							
Harvested	Acres	7,051	1,964	9,015	10,927	27	10,954
Production	Tons			15,621			24,143
Wild hay 3/							
Harvested	Acres	151	188	339	137	10	147
Production	Tons			383	241	10	251
All hay							
Harvested	Acres	8,030	3,152	11,182	13,528	1,086	14,614
Production	Tons			20,891			28,753
Value	Dol.			457,095			715,950
Vegetables							
Harvested	Acres	4	0	4	2	0	2
Value	Dol.			427			290
Fruit orchards							
Harvested	Acres	258	22	280	99	10	109
Value	Dol.			21,560			8,393
Total harvested croplsnd							
Harvested	Acres	14,163	10,696	24,859	17,966	6,249	24,215
Value	Dol.			991,054			1,083,531
Cropland pasture	Acres	11,185	6,186	17,371	17,340	4,407	21,747
Other crop and pasture	Acres	21,702	2,668	24,370	12,894	5,744	18,638
Total cropland	Acres	47,050	19,550	66,600	48,200	16,400	64,600

1/ Converted to grain st the approximate rate of 1 ton silage = 5 bu. grain.

2/ np = no production reported.

3/ Totals are included in "All Hay."

Source: U. S. Bureau of the Census; Colorado Agricultural Statistics, 1943-1965; USDA Field Party

noticeable shift in cropland classified as other crop and pasture further substantiates this point because 37 percent (24,400 acres) of the total cropland in 1943-60 dropped to 29 percent (18,600 acres) in 1965.

There are approximately 26,700 acres of irrigated and subirrigated pasture (including noncropland as well as cropland areas) in the Dolores River Basin. A considerable portion of this irrigated pasture is on poor quality land, on land with a short water supply, or on fields that are small, irregular and quite often difficult to economically justify intensive agri-management operations.

With the exception of oats, acreage in grain production has declined from the average levels of the 1943-60 period. Declines are noted in irrigated land for four of the six grain crops grown in the basin; winter wheat and oats are cited as the exceptions. Likewise, acreages in potatoes, dry beans, vegetables, and fruit orchards (apples and pears) are currently below the study period averages. Although no high value cash crops are produced in the basin, the combined gross value of all harvested crops was about $1.1 million in 1965. During the 1943-60 period this amount was slightly less than $1.0 million per year. A comparison among the Colorado western slope basins of average values per crop acre harvested is shown in Table 25.

Table 25.--Average annual values per acre of harvested crop, western Colorado, 1943-60

River Basin	Value per acre (dollars)
Colorado	60
Dolores	40
Gunnison	68
White	30
Yampa	29

Source: U. S. Bureau of Census - Census of Agriculture

Range and Pasture Land

Over three-fourths of the 1,094,400 acres of the basin's national forest land is suitable for grazing by domestic livestock (Table 26). Approximately 771,400 acres designated for grazing use lie on the Uncompahgre and San Juan National Forests in Colorado and about 64,200 acres within the Manti-La Sal National Forest of Utah are allocated for livestock grazing. Collectively, these three national forests provide approximately

130,600 animal unit months of grazing annually. In 1965, 166 permittees had permits for 25,657 herd of cattle for a total of 104,800 animal unit months, and 45 permittees had permits for 61,056 head of sheep for a total of 25,800 animal unit months of grazing. Average length of grazing season is four months for cattle and two months for sheep.

Subalpine rangeland
(soil mapping unit 7)

Rangeland administered by the Bureau of Land Management (BLM) provides an estimated 45,200 animal unit months of grazing per year. In terms of acreage, 38 percent of the total rangeland is supplied by Bureau of Land Management land. Domestic livestock carrying capacity of the 413,800 acres of private and state-owned rangeland is estimated to be 46,000 animal unit months of grazing annually. In contrast to some other areas private and state land supplies only 21 percent of the total rangeland acreage.

In addition to rangeland grazing, it is estimated that under present conditions livestock obtain about 65,700 animal units months from pasture (irrigated and dryland) and about 8,300 AUM's of grazing from crop aftermath. Hay and corn collectively contribute an estimated 109,100 animal unit months of feed equivalent. Assuming that the livestock industry will continue to expand, irrigated pasture and cropland grazing (early spring crop aftermath and field residues) must be

Table 26.--Grazing use by livestock, Dolores River Basin in Colorado and Utah, 1965

Source	Area		Grazing/forage	
	Acres	Percent	Animal unit months	Percent
Rangeland				
U. S. Forest Service 1/	835,600	42	130,600	59
Bureau of Land Management	759,200	38	45,200	20
Private	373,600	18	41,500	19
State	40,200	2	4,500	2
Total - rangeland	2,008,600	100	221,800	100
Cropland				
Irrigated pasture and cropland grazing	45,500	66	70,400	38
Dry cropland and planted pastures 2/	7,200	11	3,600	2
All hay 3/	14,600	21	89,000	49
Corn silage 4/	1,500	2	20,100	11
Total - cropland	68,800 5/	100	183,100	100
Total	2,077,400	-	404,900	-

1/ Forest Service animal months converted to animal unit months.

2/ Does not include summer-fallow lands.

3/ Conversion equivalent: 3 AUM's per ton of hay.

4/ Approximate rate of exchange: 5 bu. grain = 1 ton silage.

5/ Exceeds total cropland acreage as shown in Table 22 because of aftermath grazing.

a major source of increased forage. Consequently, if the irrigated acreage is increased, a proportionately larger share of this acreage will need to be in irrigated pasture to balance future livestock forage supplies.

Livestock

The agricultural economy of the Dolores River Basin is oriented to the livestock industry. From a historical perspective the livestock industry has been the principal market for crop, forage, and pasture production in the basin. Trends in livestock numbers are presented for the 1944-64 period in Table 27.

Table 27.--Livestock numbers, Dolores River Basin in Colorado and Utah, 1944-64

Livestock	1944	1949	1954	1959	1964
	Number	Number	Number	Number	Number
Cattle and calves	9,494	17,789	22,012	29,012	33,939
Cows including heifers that have calved	5,714	9,336	11,844	14,724	14,621
Milk cows	923	1,019	1,086	627	410
Horses and/or mules	1,508	1,359	1,195	1,334	1,300 1/
Hogs and pigs	1,074	1,390	1,331	1,478	682
Sheep and lambs	43,023	33,255	58,379	63,576	64,358
Ewes	32,783	25,534	44,248	47,613	55,450
Chickens 4 months old and over	15,248	12,547	21,134	8,484	11,321

1/ An estimate as the 1964 Census of Agriculture did not tabulate horses and/or mules.

Source: U. S. Bureau of Census - Census of Agriculture, Soil Conservation Service, and Agricultural Stabilization and Conservation Service.

Cattle numbers have more than tripled since 1944. The number of sheep has increased about 20,000 (or 50 percent) although only a slight gain is noted from 1959 to 1964. Declines are evident for milk cows, chickens, and hogs and pigs. Horses and/or mules have been relatively stable from 1944 to 1959.

During the 1943-60 period an average of about 23,100 animal units of livestock were on ranches headquartered in the basin. However, the present estimate (1964) is approximately 32,500 animal units. Presently, livestock use an estimated 295,800 animal unit months of grazing plus an estimated 109,100 animal unit months of winter feed produced on the irrigated and dry cropland. The balance of grazing available within the basin (404,900 - 390,000 = 14,900 animal unit months) is consumed by livestock headquartered outside the basin. This use is mostly by migratory bands of sheep that winter in the Colorado River Main Stem Basin of Utah and migrate to the high mountain pastures in the summer.

Agricultural Income

The general trend in gross farm income is presented with emphasis on the component sources of income and changes that have occurred in the last two decades. Two income measures are presented for 1964. The first measure is "realized net income of farm operators from farming," which views agriculture from a business or industry standpoint. It is defined as cash receipts from farm marketing, government payments, and nonmoney income, less farm production expenses, grazing fees, taxes, and interest paid on borrowed capital. The second income measure is "realized net income of farm families from all sources." This second income measure includes income earned off the farm in addition to income earned from farm sources. Both measures have the obvious limitation of grouping all farms together, thus tending to obscure the variability of income among farms. However, they do provide an insight into the current economic condition of agribusiness in the Dolores River Basin.

General Trends in Gross Receipts From Farm Sales

During the period from 1944 to 1964, two major changes occurred in farm sales in the basin. First, there was a significant increase in the level of farm receipts from farm sales. And second, important changes occurred in the composition of farm sales (Table 28).

Sales of all farm products increased from $2.1 million in 1944 to $5.0 million in 1964. Average annual growth during the 20-year period was $145,000 or 7 percent. Growth for the State of Colorado during the same

Table 28.--Value of farm products sold, Dolores River Basin in Colorado and Utah, 1944-1964

Commodity	1944 (Dollars)	1949 (Dollars)	1954 (Dollars)	1959 (Dollars)	1964 (Dollars)	1944 Percent	1949 Percent	1954 Percent	1959 Percent	1964 Percent
Field crops	296,358	752,683	583,092	415,756	358,898	14.2	23.3	18.6	10.0	7.2
Vegetables	808	37	463	400	390	0.1	1/	0.1	1/	1/
Fruits and nuts	13,049	6,234	49,625	17,329	8,393	0.6	0.2	1.5	0.4	0.2
Total crops	310,215	758,954	633,180	433,485	367,681	14.9	23.5	20.2	10.4	7.4
Dairy products	74,822	67,307	107,287	80,982	76,811	3.6	2.1	3.4	1.9	1.5
Poultry and poultry products	43,979	31,529	60,590	34,108	39,548	2.1	1.0	1.9	0.8	0.8
Livestock and livestock products 2/	1,649,638	2,376,792	2,320,796	3,515,895	4,496,139	79.1	73.4	74.2	84.2	90.1
Total livestock and livestock products	1,768,439	2,475,628	2,488,673	3,630,985	4,612,498	84.8	76.5	79.5	86.9	92.4
Forest products and horticultural specialities	5,685	1,248	8,280	112,577	11,442	0.3	1/	0.3	2.7	0.2
Total farm products	2,084,339	3,235,830	3,130,133	4,177,047	4,991,621	100.0	100.0	100.0	100.0	100.0
Gross sales per farm	4,998	7,970	6,864	11,571	14,021					
Value of farm products sold in terms of 1964 dollars	1964 Dollars	1964 Dollars	1964 Dollars	1964 Dollars	1964 Dollars					
Total crops and forest products and horticultural specialities	345,000	719,900	596,600	572,800	379,100					
Total livestock and livestock products	2,886,100	2,374,100	2,787,300	3,278,800	4,612,500					
Total farm products	3,231,100	3,094,000	3,383,900	3,851,600	4,991,600					
Gross sales per farm	7,748	7,621	7,421	10,669	14,021					

1/ Less than 0.1 percent.

2/ Other than dairy and poultry products.

Source: U. S. Bureau of Census - Census of Agriculture; and Colorado Crop and Livestock Reporting Service.

time also was 7 percent annually. Value of farm products sold was converted to 1964 dollars to remove the factor of inflation. In terms of 1964 dollars the value of sales has increased from $3.2 million to $5.0 million, a gain of 56 percent. Likewise, the value of sales per farm increased from $7,748 in 1944 to $14,021 in 1964 (measured in 1964 dollars). This represents a gain of 81 percent in constant dollars compared to an increase of 181 percent from reported gross sales without adjustment. Thus, while actual dollar sales increased over two and one-half times, the actual gain registered from agricultural products sales over the 20-year period was approximately 81 percent.

The value of field crops sold averaged about $512,000 annually from 1944 to 1959. Field crop sales declined from this study period average (about 17 percent of all farm sales) to $358,900 (seven percent of all farm sales) in 1964. The average value of all crop production was about $1.1 million in 1964 (Table 24). The difference of approximately $716,000 or 66 percent is an estimate of hay fed to livestock on farms where they were raised. The commodity categories of vegetables, fruits and nuts, forest products, and horticultural specialities each contributed minor amounts, all averaging less than one percent, to the total farm products sold.

Irrigated cornfield
(soil mapping unit 4)

Sale of livestock and livestock products, principally cattle and sheep, increased from $1.6 million (79 percent of all farm sales) in 1944 to $4.5 million (90 percent of all farm sales) in 1964, or a 181 percent increase. Sales of dairy and poultry products averaged roughly two percent of the total farm sales over the 20-year period.

Realized Gross and Net Farm Income From Farm Sources

The components of realized gross income from farm sources are: (1) cash receipts from farm marketings, (2) government payments, and (3) nonmoney income. When expenses (e.g., farm production costs, grazing fees, taxes, and interest) are subtracted from gross income, farm operators realized net income from farm sources is obtained.

Sources of realized gross farm income for the basin in 1964 are summarized in Table 29. The basin's farm product sales amounted to $5.0 million, or 94 percent of the total. Government payments, which amounted to $215,400 or four percent of the total, consisted of: (1) Agricultural Conservation Program 7/ ($50,700), (2) Conservation Reserve Program or more commonly known as "Soil Bank" ($31,200), (3) Feed Grain Program ($25,500 for diversion and $3,400 for price support), (4) Wheat Program ($1,500 for diversion and $43,900 for certificates), (5) Wool Incentive Program ($57,600), and (6) 1964-65 FY Disaster Livestock Feed Program ($1,600).

Nonmoney income, or the value of farm products consumed directly by farm household and rented values of the farm house, contributed $94,000 ($264 per Colorado farm household). Realized gross farm income from all sources amounted to $5.3 million in 1964.

Total farm production expenses were estimated to be $2.6 million. Taxes, interest, and grazing fees are estimated at $505,800, $342,300, and $89,100, respectively. These expenses total about $3.5 million and when subtracted from gross farm income yield a "realized net farm income" of $1,784,600, or about 36 percent of the gross receipts (Table 29). Average per farm net income from farm sources is $5,013. Since nonfarm income received by farm operators or members of their families and/or households is not included in this estimate, it should not be interpreted as the average income of farm families.

7/ As of January 1, 1971, this program became the Rural Environmental Assistance Program (REAP).

Table 29.--Realized net income from farm sources, Dolores River Basin in Colorado and Utah, 1964

Item		Amount (dollars)
Farm products sales income 1/		4,991,600
Government payments 2/		215,400
Nonmoney income 3/		94,000
Realized gross income		5,301,000
Expenses:		
Farm production	2,579,200	
Grazing fees	89,100	
Taxes (Property, personal, sales)	505,800	
Interest (Farm mortgage, personal)	342,300	
Total operational expenses		3,516,400
Realized farm net income		1,784,600
Realized net income per farm unit		5,013

1/ From Table 28.

2/ Colorado Agricultural Stabilization and Conservation Service Programs, Annual Report for 1965, USDA, ASCS State Office, Denver, Colorado (for Colorado only).

3/ Value of home consumption is based on the state average of approximately $264 per farm in 1965 as derived from Agricultural Statistics, 1966.

Income From All Sources

Nonfarm income of farm operators, and members of their families was equal to 67 percent of their net income from farm sources, Table 30. Wages and salaries earned by farm operators and their families amounted to $811,300, or 68 percent of the $1,191,600 nonfarm income. Income from nonfarm business and professions totaled $174,800 (or 15 percent). Social security, pensions, veterans and welfare payments were $71,500 or six percent of the nonfarm income. Rent from farm and nonfarm sources,

interest, dividends, and other income contributed $134,100 (11 percent). Income from all sources totaled $2,976,600 and an estimated income of $6,905 per farm family is derived. The per capita net income of the basin's farm population is $1,760.

Table 30.--Income of farm operators and their families from all sources, Dolores River Basin in Colorado and Utah, 1964

Item	Amount (dollars)
Realized net income of farm operators from farm sources 1/	1,784,600
Income of farm operators and their families from nonfarm sources 2/	1,191,600
Income of farm population from all sources	2,976,200
Income per farm family	6,905
Per capita income of farm population	1,760

1/ From Table 29.

2/ U. S. Census of Agriculture, 1964, adjusted to basin boundaries.

Projected Development

The economy of the basin has been firmly established on mining, agriculture, and forestry. Within the past decade outdoor recreation has gained considerable impetus as an industry and as a reliable addition to the basin's overall economy. Future growth will stem from the development of all these sectors, but the greatest surge will come mainly from developing the basin's outdoor recreation potentials.

Implicit in this section is the completion of the Bureau of Reclamation's San Miguel Project by the year 2000, as described in Chapter VII. Specific impacts on the various sectors of the economy have been examined and are presented in terms of employment, income, and population. Adjustments in land use will be particularly important for agriculture because they pose a significant contrast to historical trends. Due to infrastructural changes (larger farm units, declining rural farm population, greater irrigated acreages, and shifts toward a predominantly livestock agriculture) occurring in the basin, the amount of suitable agricultural land to support a given number of farm families has stabilized. However,

an estimated 26,000 acres of new land will be brought into irrigated production by the San Miguel Project. This major water development should prevent a further decline in farm units and at the same time stabilize the rural farm population. The mineral resources industry and outdoor recreation also will gain directly from the project. For the former, an increase in coal production for electric power generation is expected as well as more jobs if a new plant is constructed. For the latter, it will mean a boost to existing businesses to absorb some underemployment plus the likelihood of establishing new businesses to service the demands of the recreation industry.

Agricultrual Production

Potential crop and livestock production is contingent upon many factors, some more relevant than others. New land brought under irrigation provides opportunities for agricultural development as well as creating shifts in resource allocation. In order to determine the magnitude and significance of these changes, it is essential to forecast a crop distribution and to predict livestock numbers. But even before estimates can be made, several assumptions are necessary to provide meaningful results. These assumptions have been grouped into two categories: general and specific.

General assumptions used in the process of making agricultural projections were:

(1) That general economic stability will prevail during the projection period, that no major war or economic recession will occur, and that a high level of economic activity and nearly full employment will be maintained. However, this does not preclude periodic cyclic adjustments in economic activities.

(2) That government programs will exist during the projection period but that market forces will be the dominant factor in allocation of resources. This implies a gradual decrease in production restraints and greater market influence during the projection period.

(3) That government programs in research and extension will continue at present levels.

(4) That marketing and transportation facilities will be adequate to handle the projected agricultural production.

(5) That current normal relationships among inputs, and between inputs and outputs, will continue through the projection period.

(6) That credit availability, tenure arrangements, zoning, and taxation policies will not interfere with agricultural adjustments, including farm consolidation or adoption of new technologies.

(7) That fertilizer and livestock feeds of needed types and in sufficient quantities will be available at current normal prices. 8/

Specific assumptions relating directly to the Dolores River Basin include:

(1) Completion of the San Miguel Project as reported in U. S. House Document No. 435, 89th Congress, 2nd Session (1966).

(2) Use of crop yield rates and livestock feeding efficiencies provided by Colorado State University Experiment Station.

Adjustments in Land Use

At present 73.2 percent of the land in the basin is in federal ownership and will probably remain so for the next 50 years. This land is administered by the U. S. Forest Service and the Bureau of Land Management. In relation to other uses, the most significant trend in federal multiple use land management has been increased recreational use. Approximately 724,200 acres of land (24.4 percent) is in private ownership while the balance of 71,700 acres (2.4 percent) is designated as state land. Little , if any, ownership change is anticipated for this land in the future.

American agriculture has changed rapidly over the last two decades, largely because of the high level of economic development. At different stages of economic growth, agriculture assumes distinct structural characteristics. These characteristics are based primarily on the state of knowledge and the prices attached to different resources. Since the economy of the United States is highly developed and mature, structural change in agriculture is sure to continue at an accelerated rate. 9/

8/ The current normal price relationships refer to the "Interim Price Standards for Planning and Evaluating Water and Land Resources," as approved by the Interdepartmental Staff Committee of the Water Resources Council, Washington, D. C., April 1966.

9/ Heady, Earl O., "Trends in the Structure of Farming" in Journal of Soil and Water Conservation. September-October 1967. pp. 180-184.

Because the Dolores River Basin is relatively isolated from primary transportation routes, it has not experienced the full impact of current structural chages in agriculture. Even though the basin is operating at a lower level of economic resource development than that of the nation, it strives to emulate the standard established by the more progressive rural areas. These factors indicate that the basin's agricultural economy is responsive to relative prices of resources under economic development. Too, as individual farm units change, land use will change because individual farms will become more specialized.

Range forage utilization by sheep
(soil mapping unit 5)

As the basin's principal user of land, agriculture utilizes about 69 percent of the land for crop and livestock production. Irrigated and dry cropland pasture has increased from the 1943-60 average of 17,400 acres to a present acreage of 21,700. Quite probably this trend will continue as a means of : (1) offsetting reduced grazing permits on federal rangeland, and (2) increasing the productivity of the basin's livestock industry. Table 31 shows estimates of changes in land use for 2020 and the intervening 20-year periods following 1965. These projections were made to estimate potential consumptive water requirements and indicate trends in land use and agricultural production.

Table 31.--Present and projected land use, Dolores River Basin in Colorado and Utah, 1965-2020

	Present	Projected		
	1965	1980	2000	2020
Cropland	64,600	61,900	86,000	84,500
Irrigated	(48,200)	(46,900)	(73,000)	(73,000)
Nonirrigated	(16,400)	(15,000)	(13,000)	(11,500)
Grazing	881,200	880,300	878,000	878,000
Timber and grazing	1,127,400	1,127,900	1,123,200	1,120,400
Timber	703,700	703,100	678,500	673,400
Other	193,200	199,700	207,200	216,600
Primitive Area 1/	(27,800)	(27,300)	(27,300)	(27,300)
Recreation 2/	(42,800)	(46,500)	(48,700)	(52,700)
Towns, inhabited areas, water courses, roads, shale, rock, mineral lands, etc.	(123,100)	(125,900)	(131,200)	(136,600)
Total	2,970,100	2,972,900	2,972,900	2,972,900

1/ Grazing is presently permitted on 11,200 acres of the Wilson Mountains Primitive Area.

2/ Developed recreation water and land areas; does not include all of the multiple use lands of the national forests and Bureau of Land Management.

Source: Developed by USDA Field Party

Irrigated cropland averaged about 47,050 acres during the 1943-60 period (Table 24). By 1965 it had increased to 48,200 acres. The projection for 2020 estimates irrigated acreage to total 73,000 acres; of this total, 59,800 acres (82 percent) would have a full water supply. The acreage of crops is projected to be 46,400 or about 64 percent of the total irrigated acreage. Approximately 33,500 acres of this would be devoted to hay production and the balance (12,900) would be distributed among corn, small grains, potatoes, beans (dry), and fruit. The acreage of irrigated cropland pasture in 2020 is an estimated 21,100 acres. An additional 2,500 acres are projected for dry cropland pasture, thus giving a 2020 estimate of 23,600 acres for irrigated and dry cropland pasture.

Irrigated land projections forecast 26,400 acres of new or reclaimed land by 2020. However, an estimated 1,650 acres of irrigated land would be lost through inundation by new reservoirs. Other minor losses such as abandonment, inhabited areas, and industrialization will be balanced by seep land reclamation and private developments.

Dry farmland (nonirrigated cropland) acreage averaged about 19,600 acres in the 1943-60 period. This acreage declined to 16,400 acres in 1965. By 2020 the acreage of dry farmland will drop to about 11,500 acres. The major part of this will occur as a result of irrigation of present dry croplands and some conversion of dry farmlands to dry pasture and grassland.

The land use categories of grazing, timber and grazing, and timber will experience small decreases from present levels (Table 31). The 2,800 acres of Narriguinnep Natural Area, administered by the U. S. Forest Service, is programmed for declassification from its special use category within the next few years. It will revert primarily to grazing and timber and grazing uses. The "other" category in the projected land use table is estimated to increase nearly 11 percent. Within this classification, approximately 9,900 additional acres of land will be developed for recreation by 2020, representing a 23 percent gain over the 55-year period.

Crop Production

Considering the foregoing assumptions, estimates of crop production are presented in Table 32 for irrigated land and in Table 33 for dry cropland. By 2020 irrigated cropland acreage is expected to increase from 48,200 to 73,000, a gain of 24,800 acres (over 51 percent). Conversely, dry cropland is expected to decline 30 percent, from 16,400 acres to 11,500 acres by the same date.

Table 32.--Present and projected irrigated cropland, Dolores River Basin in Colorado and Utah, 1965-2020

Crop	1965	1980	2000	2020
	Acres	Acres	Acres	Acres
Crop				
Corn	1,400	1,400	4,100	4,100
Small grains	2,700	2,700	5,200	5,200
Potatoes	100	100	500	500
Beans (dry)	100	100	3,000	3,000
Subtotal	4,300	4,300	12,800	12,800
Hay crops				
Alfalfa	11,000	11,000	31,000	31,000
Clover-timothy	1,100	1,100	1,400	1,400
Small grains	900	700	1,000	1,000
Wild hay	100	100	0	0
Other hay	500	400	100	100
Subtotal	13,600	13,300	33,500	33,500
Fruit orchards	100	100	100	100
Total irrigated cropland	18,000	17,700	46,400	46,400
Irrigated pasture-cropland	17,300	16,800	21,100	21,100
Irrigated pasture-noncropland	12,900	12,400	5,500	5,500
Total	48,200	46,900	73,000	73,000

Source: Developed by USDA Field Party

Alfalfa, projected to nearly triple in irrigated acreage, will continue to be the single most important winter feed supply for the anticipated growth in livestock numbers. Other irrigated crops that are most likely to show significant increases are corn, small grains (principally barley, oats, and winter wheat), and dry beans. Irrigated pasture is expected to increase from 17,300 acres to 21,100 acres, a 22 percent increase. Less

Table 33.--Present and projected dry cropland, Dolores River Basin in Colorado and Utah, 1965-2020

Crop	1965	1980	2000	2020
	Acres	Acres	Acres	Acres
Crop				
Corn	30	0	0	0
Small grains	2,410	2,400	2,000	2,000
Beans (dry)	2,720	2,700	1,000	1,000
Subtotal	5,160	5,100	3,000	3,000
Hay crops				
Alfalfa	30	0	0	0
Clover-timothy	100	100	100	100
Small grains	600	500	500	500
Wild hay	10	0	0	0
Other hay	350	200	200	200
Subtotal	1,090	800	800	800
Total dry farm	6,250	5,900	3,800	3,800
Cropland pasture	4,410	4,000	3,000	2,500
Pasture-noncropland	5,740	5,100	6,200	5,200
Total	16,400	15,000	13,000	11,500

Source: Developed by USDA Field Party

productive, marginal land (termed irrigated pasture-noncropland) is expected to steadily decrease over the next 50 years until the estimated 2020 acreage approximates 5,500.

The general decline in dry cropland projections is primarily attributed to two factors: (1) past historical trends (viz., conversion from a general farming economy to livestock operations), and (2) climatic conditions -- short growing season and lack of rainfall.

Except for dry beans no significant decline for any one crop is anticipated in the dry cropland distribution (Table 33). The dry bean decline will be more than absorbed by the projected increases for that crop as present and potentially irrigable land receives water.

Livestock Production

In order to obtain livestock production projections it was essential to estimate potential feed and forage productivity. The following agricultural aspects were considered in deriving livestock feed and forage projections: crop yield projections (rates), livestock feeding efficiencies, increased irrigated crop and pasture land, and implementation of new pasture and range management technology. Table 34 presents projected changes in production of livestock feed and forage for the basin from present conditions to the years 1980, 2000, and 2020.

Rangeland grazing is projected to produce 244,000 animal unit months of grazing by 2020. This represents an increase of 20,600 (ten percent) from the 1965 total of 221,800 animal unit months of grazing. 10/ For the most part this increase is responsive to new range management technological efficiencies, even though most of 57,000 acres that is projected to move out of grazing use is low productive rangeland.

Cropland grazing is estimated to supply 107,600 animal unit months (12 percent of total grazing) by 2020, a 45 percent increase from present conditions. Approximately 16,100 acres of hay and corn (silage), irrigated and dry farm, yield an estimated 109,100 animal unit months of winter feed supplies. With improvement in water management, it is estimated that by 2020 nearly all (98 percent) winter feed will be produced on irrigated cropland. An estimated 34,300 acres will be farmed as hay and approximately 4,100 acres for corn silage. Projections indicate that this hay and silage would provide about 559,400 animal unit months of winter feed supplies.

As previously mentioned, the Dolores River Basin provides year round feed and forage supplies for about 32,500 animal units of livestock plus an estimated 14,900 animal unit months of grazing for migratory livestock. The 911,000 animal unit months of feed and forage projected in 2020 would

---

10/ The 1965 estimate of 221,800 AUM differs somewhat from the 204,500 AUM estimate derived by the range survey presented in Chapter III, but nevertheless, with increased use of dry pasture rangeland, particularly at the higher elevations where the precipitation is higher, the 2020 projection of 244,000 AUM is still considered a realistic estimate.

Table 34.--Livestock feed and forage production projections, Dolores River Basin in Colorado and Utah, 1965, 1980, 2000, and 2020

Year	Source					Total feed and forage production
	Rangeland grazing	Cropland grazing			Hay and silage	
		Irrigated	Dry farm	Total		
1965						
Acres	2,008,600	45,500	7,200	52,700	16,100	2,077,400
Animal unit months	221,800	70,400	3,600	74,000	109,100	404,900
1980						
Acres	1,992,700	45,200	7,200	52,400	15,500	2,060,600
Animal unit months	224,800	82,300	3,900	86,200	146,000	457,000
2000						
Acres	1,954,500	65,300	6,600	71,900	38,400	2,064,800
Animal unit months	234,400	104,400	4,500	108,900	459,200	802,500
2020						
Acres	1,951,600	65,300	5,300	70,600	38,400	2,060,600
Animal unit months	244,000	104,400	3,200	107,600	559,400	911,000

Source: Developed by USDA Field Party

provide balanced feed and forage for 75,900 animal units of domestic and migratory livestock. In terms of 1964 dollars the gross returns for livestock and livestock products is expected to be $10.7 million in 2020 compared to $4.6 million in 1964.

Economic Effects

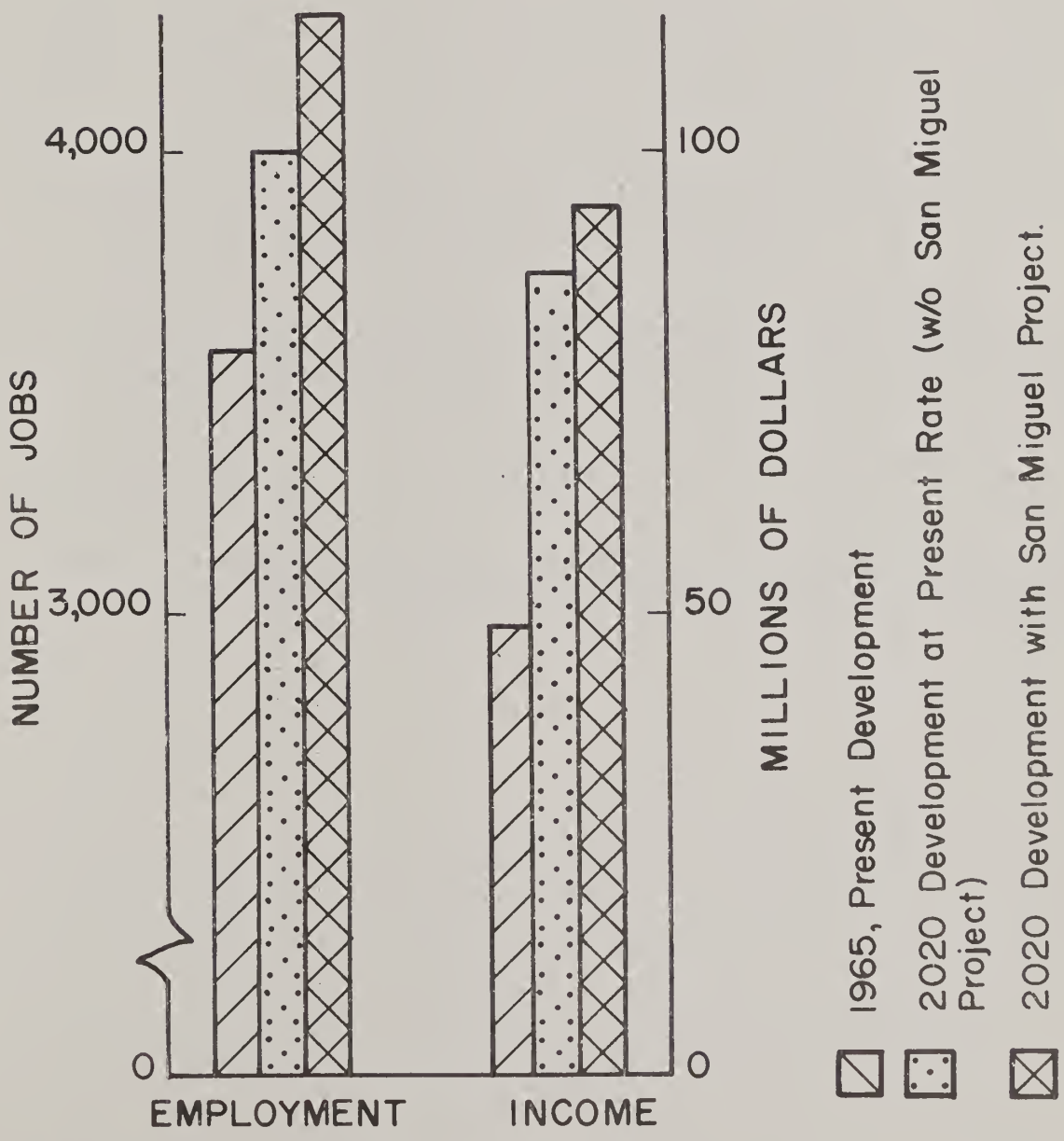
Certain impacts will occur as a result of water resource development. Those, of course, receiving the greatest benefits are the individuals whose livelihood is directly affected (viz. the farmers and ranchers). However, just as important perhaps will be those sectors of the economy that require water development to enhance overall community growth. Here, the main beneficiaries appear to be the mineral resources industry (principally thermal electric generation) and outdoor recreation.

Historically, the basin's employment has shifted at the whim of mining. Recent events 11/ indicate a more stabilizing trend for the mining industry. Present mining operations are not large consumers of water (less than one percent of the basin's present consumption), but the construction of a new large (750 megawatt) thermal electric power generating facility in the vicinity of Naturita would place tremendous new demands for plant cooling water. Likewise, additional demands for coal to supply the new power generating facility will create employment opportunities. An important aspect of the construction of the San Miguel Project would be to arrest the slumping agricultural employment. An estimated 50 additional farm units would be added -- thus a direct deterrent in halting the sagging farm economy. Employment gains also are anticipated for outdoor recreation and the construction industry (Table 35). Figure 5 graphically portrays the projected levels of employment at the current rate of growth as well as considering the development and subsequent impact of the San Miguel Project. A comparison of present and projected gross income for the primary industries of the basin is illustrated in the same figure. As a result of the San Miguel Project, an annual gross income of approximately $7.1 million would be brought into the local economy.

11/ An increase in the demand for uranium oxide concentrate to fuel many of the nation's new electric power generating plants; a continuing demand for vanadium in strengthening steel alloy tools; higher, more stable price levels for silver; and other less significant items.

PRESENT AND PROJECTED BASIN EMPLOYMENT AND GROSS INCOME (PRIMARY INDUSTRIES, ONLY) WITH AND WITHOUT SAN MIGUEL PROJECT

DOLORES RIVER BASIN IN COLORADO 1965 AND 2020



Source: Developed by USDA Field Party

Figure No. 5

Table 35.--Local impacts of San Miguel Project, Dolores River Basin, 2020

Sector of economy	Gross income	Employment	Population
	Million dollars	People	People
Agriculture	1.5	50	200
Mineral resources (and thermal electric power generation) 1/	3.2	100	400
Outdoor recreation	0.2	10	40
Construction	1.5	10	40
Subtotal	6.4	170	680
Secondary impacts	0.7 2/	130 3/	520 3/
Total	7.1	300	1,200

1/ Basic data re electric power generation from Colorado-Ute Electric Association, Montrose, with conversion factors supplied by the Bureau of Reclamation, Salt Lake City, Utah.

2/ Procedure established by McArthur and Coppedge, "Derivation of Income Multipliers as Tools for Impact Analysis," (Review draft, Economic Research Service, Salt Lake City, Utah, March 1968, 20 pages) was used in determining the additional (secondary) income.

3/ Approximated on a 1.0 to 0.8 ratio of primary to secondary industries.

Source: Developed by USDA Field Party from information provided by Colorado-Ute Electric Association and Bureau of Reclamation.

Three levels of population growth are envisioned for the basin. Corresponding to their curves projected to 2020 in Figure 6, the population alternatives are described as follows:

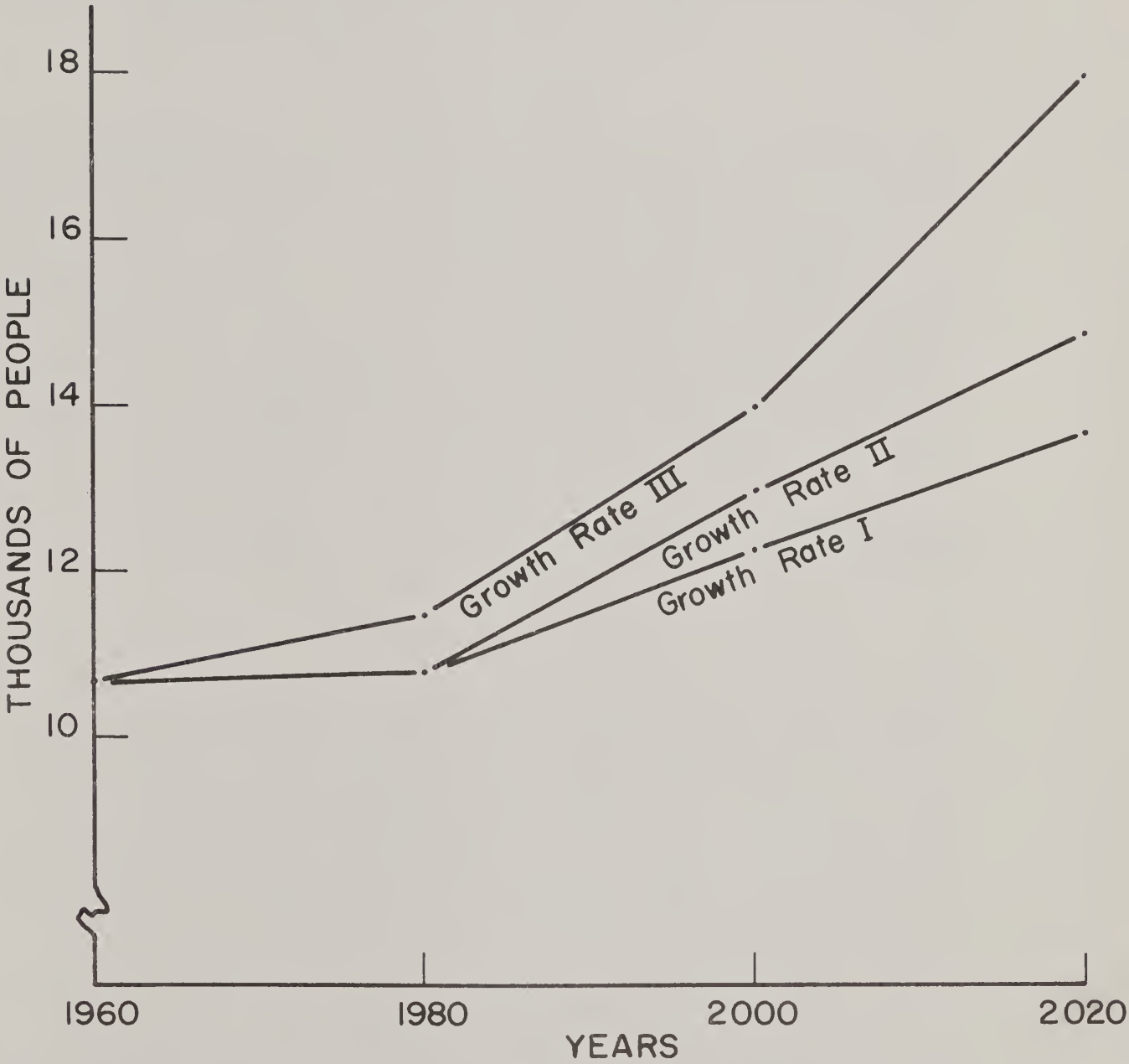
Projection	Description
Growth rate I	This projection emulates the 0.62 percent annual average rate of growth for the basin during the 1920-60 time period, i.e., it is based essentially upon a historical trend. This level of population growth is not constrained by water resource availability.
Growth rate II	In addition to the basin's historical growth rate, the effects of the San Miguel Project are implied.
Growth rate III	This projected curve reflects all facets of development; it epitomizes the ultimate in economic growth and development for the most isolated of the six river basins in western Colorado. Prerequisites for this level of growth assume: (1) a stable agricultural economy, (2) no major downturns in the mining industry, (3) solution to land and air transportation problems, (4) creation of new recreation service industries that are associated with planned water resource developments, (5) ingenuity of basin leadership in broadening the economic base by attracting and locating small, light manufacturing firms into the basin, and (6) implementation of early action USDA programs outlined in Chapter IX.

Although physically located in the basin, the Dolores Project will have major impacts on the economy in the San Juan River Basin. However, some economic effects from outdoor recreation facility development will be experienced in the Dolores River Basin. Of the total estimated annual recreation expenditures of $1.1 million, approximately 20 percent or $220,000 will be spent in the Dolores River Basin. This will, of course, provide some employment opportunities. These estimates have been considered and are incorporated in the population growth rate III alternative presented above.

Social and Institutional

Translating population growth into tangible social services required is a formidable task. However, there will be a definite need for better schools, libraries, hospitals, improved roads, recreation facilities, and general services. To what extent each of these must be improved should seriously concern the leadership of the basin.

POPULATION PROJECTIONS
DOLORES RIVER BASIN
IN
COLORADO AND UTAH, 1960-2020



Source: Developed by USDA
Field Party.

Figure No. 6

In his recent book Clawson [12] concludes that "...the cost of truly modern living conditions is higher in rural than in urban areas." In other words, rural areas as compared to urban areas are at a distinct disadvantage in offering the amenities of life. Under our present economy, these conditions favoring urban areas are nearly immutable. Nevertheless, rural areas, through sound decision-making in conserving and developing their water resources, may be able to narrow this apparent gap. To be specific, proper investment of the basin's capital, time, and effort needs to focus on expansion of the economic base, eliminating underemployment, stemming the out-migration of the young adult population, and providing better, more comprehensive social services.

Outdoor Recreation

The outdoor recreation data presented in this report is in terms of the number of occasions a particular activity took place, given a level of supply. This participation is a result of the interaction between demand and supply factors and is the measurement of consequent consumption by recreationists. Some important factors influencing the demand for a recreation commodity are: tastes, population, income, distribution of income among households, cost of obtaining the experience, and prices of other commodities. The supply of outdoor recreation resources is influenced by location, concentration of activity within recreation areas, type and amount of facilities, and the quality of the resource. The participation in outdoor recreation at prevailing opportunity conditions is the interaction between demand and supply. The projected figures on recreational activity used in this report imply that the demand and supply interaction will be about the same as now; that there will be a positive shift in demand; expanded levels of supply; available facilities relative to growing population and to other circumstances and characteristics inherent to the river basin population.

Present Participation in Recreational Activities

The present participation in outdoor recreation activities in the Dolores River Basin were obtained from the Colorado Outdoor Recreation Comprehensive Plan.[13] The local participation in outdoor recreation in Colorado was obtained from a field survey by the Midwest Research Institute. The survey was based upon a stratified random sample and measured the local participation for 40 recreation activities in 3,346 Colorado households, containing 10,094 persons. The measurement was based on the number of times a person participated in a particular activity during 1966. These data were adjusted to the Dolores River Basin boundary.

12/ Clawson, Marion, Policy Directions for U. S. Agriculture. The John Hopkins Press, Baltimore, Maryland, 1968.

13/ "Colorado Outdoor Recreation Comprehensive Plan," Midwest Research Institute, Kansas City, Missouri, 1966.

Table 36 shows approximately 606,000 activity occasions occurred in the river basin in 1966. The nonresident participation amounted to slightly more than one-half. Water dependent activities contribute nearly 44 percent of the annual total participation. The resident participation in water dependent activities exceeds the nonresident participation by 10 percent. On the other hand, nonresident participation for water-enhanced activities (principally camping and big game hunting) surpasses the resident participation by 14 percent.

Future Participation in Recreational Activities

The participation in the nine most prevalent outdoor recreational activities within the basin has been projected to 1980 and 2000 and is shown in Tables 37 and 38. The forecasting was based upon the Outdoor Recreational Resource Review Commission approach to demand analysis and has been adopted by the Bureau of Outdoor Recreation and various state planners.[14/] The demand was expressed in terms of participation. The individual's participation or nonparticipation in an activity and his expressed preferences were related to certain social and economic characteristics (family income, amount of leisure time, education, etc.). Future participation was based upon an estimated increase in population, current per capita participation rates and a multivariate analysis to estimate socioeconomic shifts. Although the forecasting and demand analysis has been widely accepted, it should be noted that the multivariate analyses of the ORRRC data explained less than one-third of the variance found in the measures of participation and preference. This means that two-thirds of the variance in the sample's recreation pattern remains to be accounted for.

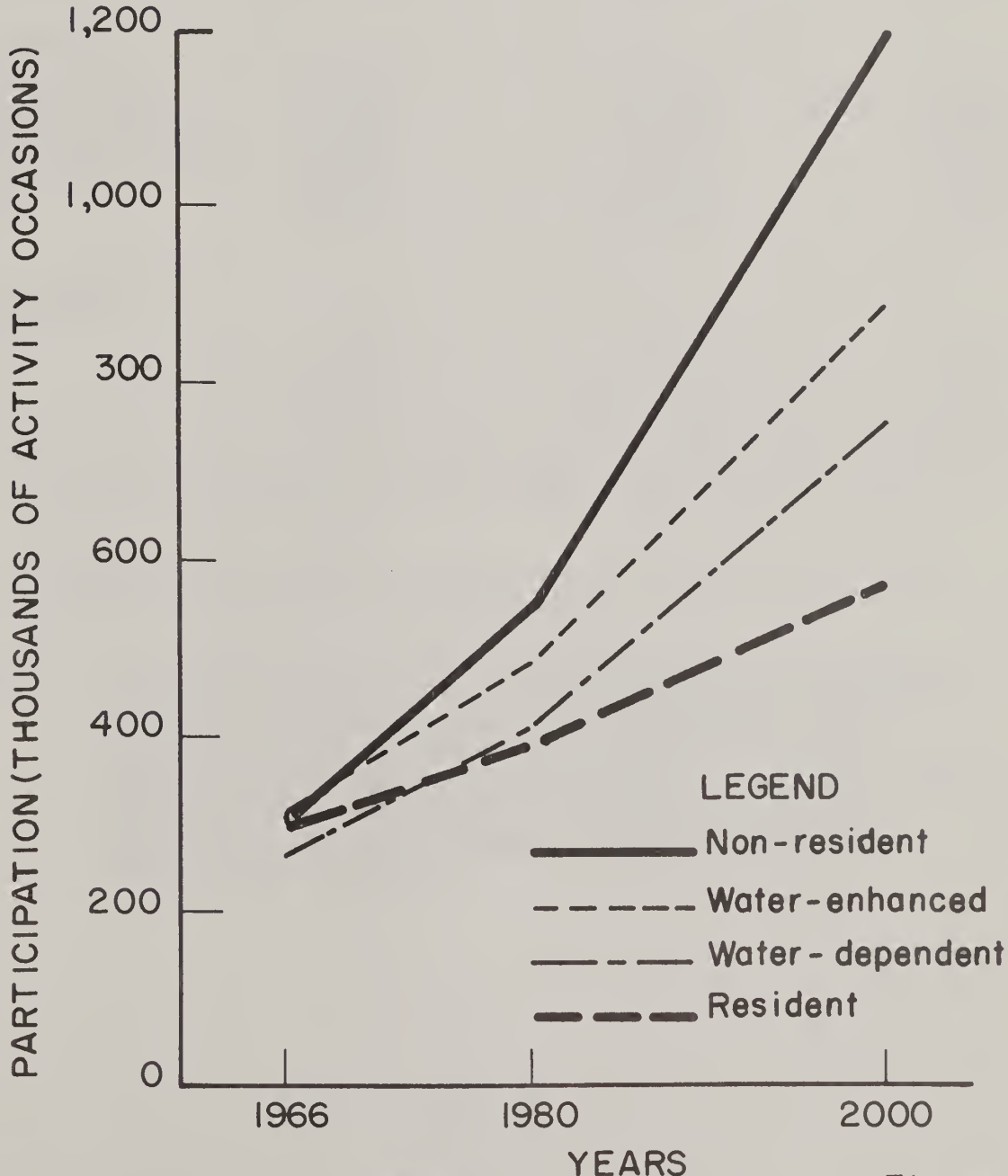
Basin resident participation was computed from the county estimates obtained from the State Outdoor Recreation Plan. Using the above described procedures for estimated future participation, 1980 and 2000 showed participation increasing 1.56 and 2.95 times, respectively. By 2000 the projections indicate that the participation by nonresidents for all nine activities, except warm water fishing and small game hunting, will exceed the resident participation.

Figure 7 illustrates the projected growth by resident and nonresident participation in water-dependent and water-enhanced activities. The highest increases, 83 percent for 1980 and 293 percent for 2000 are projections

---

14/ Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults, ORRRC Study Report 20 (1962) and Prospective Demand for Outdoor Recreation, ORRRC Study Report 26 (1962).

PROJECTED ESTIMATES OF PARTICIPATION FOR SELECTED OUTDOOR RECREATION ACTIVITIES DOLORES RIVER BASIN IN COLORADO AND UTAH, 1966-2000



Source: Tables 36, 37 and 38

Figure No. 7

Table 36.--Outdoor recreation participation, Dolores River Basin in Colorado and Utah, 1966

Activity 1/	Participation by residents (Activity occasions)	Participation by 2/ nonresidents (Activity occasions)	Total participation in river basin (Activity occasions)
Water-dependent			
Swimming	50,600	38,500	89,100
Cold water fishing	74,600	51,000	125,600
Warm water fishing	3,900	1,300	5,200
Boating	17,300	27,700	45,000
Subtotal	146,400	118,500	264,900
Water-enhanced			
Camping	25,700	60,000	85,700
Big game hunting	15,900	23,000	38,900
Small game hunting	12,800	2,600	15,400
Picnicking	82,300	93,800	176,100
Subtotal	136,700	179,400	316,100
Winter sports			
Skiing	16,300	8,400	24,700
Total	299,400	306,300	605,700

1/ The nine most actively pursued outdoor recreation activities were evaluated in this report.

2/ Assumption made in that all those not residing in the basin are considered nonresident or tourist.

Source: Midwest Research Institute, "Colorado Outdoor Recreation Comprehensive Plan"; L. J. Crampon, "A Method of Estimating Tourists and Tourist Expenditures in Colorado, 1962."; Colorado Division of Game, Fish and Parks, "Outdoor Recreation in Colorado"; Outdoor Recreation Resources Review Commission Study Report No. 19; Utah State Recreation Planning Subcommittee, "Outdoor Recreation for Utah--An Initial Plan, 1965-1975."

Table 37.--Projected estimates of participation for outdoor recreation, Dolores River Basin in Colorado and Utah, 1980

Activity 1/	Participation by residents (Activity occasions)	Participation by 2/ nonresidents (Activity occasions)	Total participation in river basin (Activity occasions)
Water-dependent			
Swimming	67,300	76,500	143,800
Cold water fishing	94,900	85,800	180,700
Warm water fishing	5,100	2,100	7,200
Boating	23,800	55,400	79,200
Subtotal	191,100	219,800	410,900
Water-enhanced			
Camping	34,200	122,400	156,600
Big game hunting	20,500	29,900	50,400
Small game hunting	17,400	3,300	20,700
Picnicking	100,300	156,800	257,100
Subtotal	172,400	312,400	484,800
Winter sports			
Skiing	22,900	25,400	48,300
Total	386,400	557,600	944,000

1/ The nine most actively pursued outdoor recreation activities were evaluated in this report.

2/ Assumption made in that all those not residing in the basin are considered nonresident or tourist.

Source: Midwest Research Institute, "Colorado Outdoor Recreation Comprehensive Plan"; L. J. Crampon, "A Method of Estimating Tourists and Tourist Expenditures in Colorado, 1962."; Colorado Division of Game, Fish and Parks, "Outdoor Recreation in Colorado"; Outdoor Recreation Resources Review Commission Study Report No. 19; Utah State Recreation Planning Subcommittee, "Outdoor Recreation for Utah--An Initial Plan, 1965-1975."

Table 38.--Projected estimates of participation for outdoor recreation, Dolores River Basin in Colorado and Utah, 2000

Activity 1/	Participation by residents (Activity occasions)	Participation by 2/ nonresidents (Activity occasions)	Total participation in river basin (Activity occasions)
Water-dependent			
Swimming	101,800	177,600	279,400
Cold water fishing	139,700	164,500	304,200
Warm water fishing	7,600	3,400	11,000
Boating	34,900	129,100	164,000
Subtotal	284,000	474,600	758,600
Water-enhanced			
Camping	50,600	292,600	343,200
Big game hunting	29,400	41,900	71,300
Small game hunting	25,000	4,600	29,600
Picnicking	150,700	296,300	447,000
Subtotal	255,700	635,400	891,100
Winter sports			
Skiing	32,900	93,100	125,000
Total	572,600	1,203,100	1,775,700

1/ The nine most actively pursued outdoor recreation activities were evaluated in this report.

2/ Assumption made in that all those not residing in the basin are considered nonresident or tourist.

Source: Midwest Research Institute, "Colorado Outdoor Recreation Comprehensive Plan"; L. J. Crampon, "A Method of Estimating Tourists and Tourist Expenditures in Colorado, 1962."; Colorado Division of Game, Fish and Parks, "Outdoor Recreation in Colorado"; Outdoor Recreation Resources Review Commission Study Report No. 19; Utah State Recreation Planning Subcommittee, "Outdoor Recreation for Utah--An Initial Plan, 1965-1975."

of nonresident participation. Future participation in water-dependent activities and water-enhanced activities are expected to nearly triple by the year 2000. Participation by residents are anticipated to double during the same time period.

Supply

In Chapter III the recreation resource base of the Dolores River Basin was discussed. As pointed out, the basin is endowed with a variety of natural resource attractions. Partly due to the economic structure of the basin as well as other lesser factors, the present supply of recreation facilities is somewhat underdeveloped.

Present Supply

Recreation supply includes those resources and facilities capable of providing outdoor recreation opportunities. Because the basin has considerable publicly-owned recreation use areas, the majority of the basin's population rely on these areas for satisfaction of their recreational needs. Consequently, outdoor recreation activity is centered around the large public land holdings administered by the U. S. Forest Service and Bureau of Land Management.

There are approximately 2,777,800 acres of land and water available for recreation in the basin. About 29 percent of this total is nonfederal ownership. Twenty-three of the basin's 48 developed recreation areas support water-dependent activities (Transportation and Recreation Area Map following page IV-12). Table 39 shows the number of developed areas with water-dependent activities by ownership class.

All of the federally-developed recreation areas are campsites or picnic areas. Fish Creek Management Area, the only developed state area, is administered by the Colorado Division of Game, Fish and Parks. It provides fishing and camping opportunities. Two local government areas, city parks for Dolores and Nucla, supply local picnicking demands while one other local government area is a swimming pool at Uravan. All eight of the quasi-public areas are privately-owned irrigation reservoirs, which are used primarily for fishing and boating.

Most of the private outdoor recreation enterprises are strategically located adjacent to federal land. The typical private recreation establishment is a small family-owned and operated vacation resort (1) with rental cabins, cottages, or lodge with a trading store, (2) providing fishing in stocked ponds or in nearby rivers or streams, and (3) offering hunting on adjacent federal land with licensed guide service often

Table 39.--Developed recreation areas with water-dependent activities by ownership, Dolores River Basin in Colorado and Utah, 1966

Ownership	Number of developed areas	Number with water-dependent activities
Federal	14	0
State	1	1
Local	3	1
Quasi-Public 1/	8	8
Private	22	13
Total	48	23

1/ Constitutes eight irrigation reservoirs that are privately-owned; however, they are normally available for public recreation use without cost.

Source: Developed by USDA Field Party

provided. Thirteen of the 22 private recreation areas have water-dependent activities, mainly fishing. Another two establishments indicate that fish ponds will be constructed in the future.

Water-Dependent Activities

The municipally-owned swimming pool at Uravan is the only developed swimming facility in the basin. This facility, constructed by the Union-Carbide Mining Company several years ago, is open for public use at a very nominal fee. Annual visitation to this pool was approximately 25,000 swimmers in 1967.

High elevation surface water is too cold for swimming because the principal source of water for lakes and reservoirs originates from melting snowpack. Another water-contact sport, water skiing, was not evaluated because of this water temperature problem which, in part, explains the lack of swimming facilities in the basin.

Private recreation resort

Cold water fishing is the most popular water-dependent activity in the basin. Cold water fishing along streams and rivers or from the shores of high-altitude mountain lakes and reservoirs is rated as a high quality recreation experience. Groundhog, Gurley, Summit, and Buckeye Reservoirs provide boat fishing. However, more anglers fish from the shoreline than from a boat. This fact is particularly true for Groundhog Reservoir, where frequent high winds create a boating hazard for small watercraft. Developed fishing facilities for general public use occur on 1,800 acres of lakes and reservoirs. In addition, trout fishermen have ample opportunity to fish along the rivers and streams.

Powerboating is primarily pursued at six privately-owned, (but open to public use) irrigation impoundments. These six impoundments provide over 1,700 acres of surface water for boating. 15/ Nonmotorboating is available on several small Forest Service lakes, totaling 55 acres. Two private recreation enterprises have reservoirs with boating facilities developed. At both sites (25 acres total) no motors are allowed.

15/ The six include: Groundhog Reservoir, 668 acres; Summit Reservoir, 420 acres; Gurley Reservoir, 363 acres; Trout Lake, 142 acres; Buckeye Reservoir, 85 acres; and Joe Moore Reservoir, 45 acres.

Water-Enhanced Activities

Table 40 shows a total of 212 campsites or about 82 acres of developed campgrounds for the basin. Seventy-one percent of the developed camping facilities are supplied by the Forest Service. The balance is provided by private (22 percent) and state (seven percent) sectors. These tent and/or trailer campsite units usually include a tent or trailer space, vehicle parking space, picnic table, fireplace, and trash receptacle. Current Forest Service campground design criteria allow for minimal disturbances to the natural environment--thus assuring high quality sites which enhance the camping experience.

Table 40.--Developed campsites by ownership, Dolores River Basin in Colorado, 1966 1/

Ownership	Number of campsites	Percent of total
Federal	150	71
State	15	7
Private	47	22
Total	212	100

1/ No developed campsites in Utah portion of the basin.

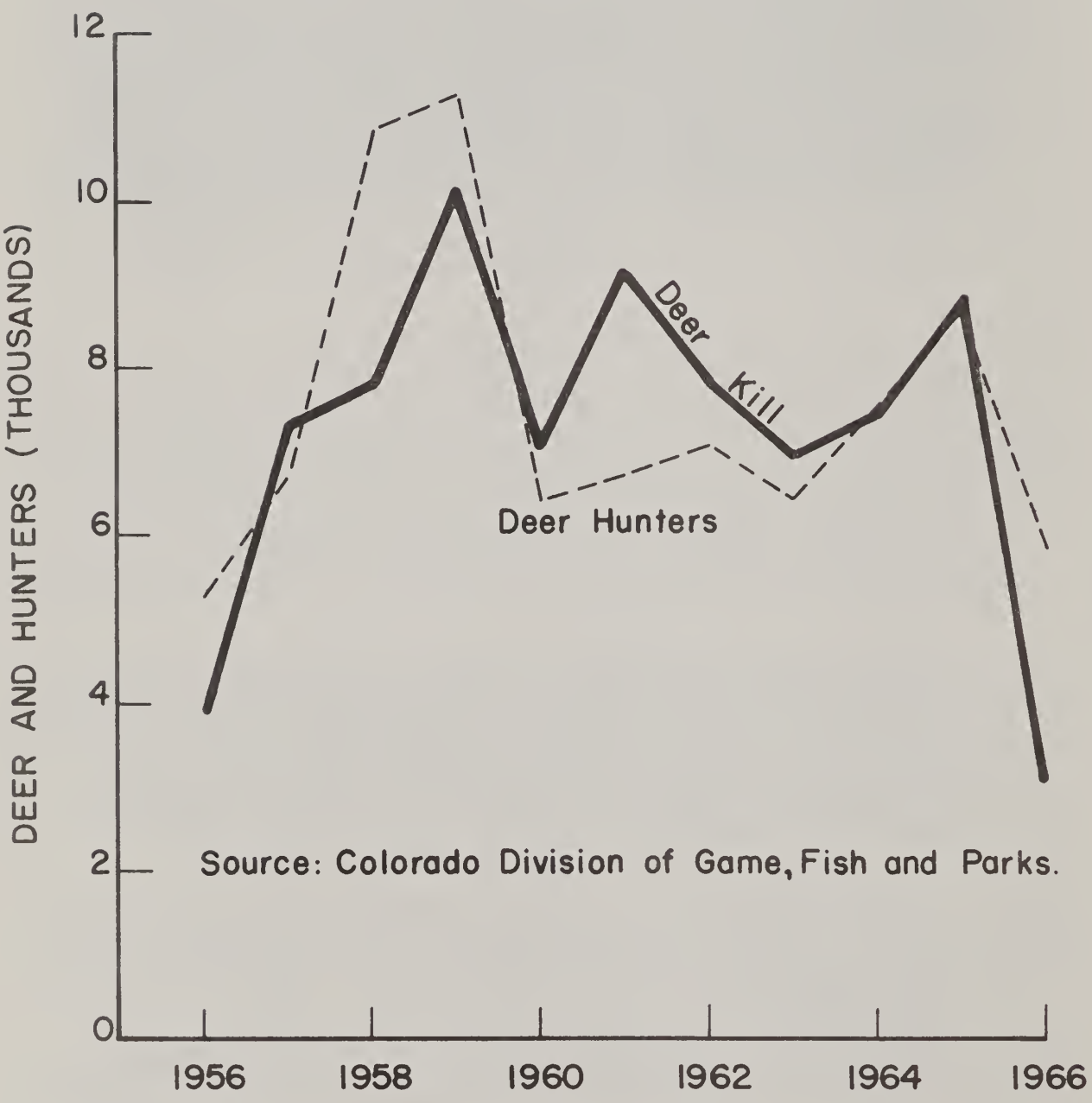
Source: Various Resource Agencies

The 1967 Colorado Recreation Survey revealed that picnicking was the second most popular activity (playing outdoor games was first). Perhaps it is highly popular because it involves little expense other than travel costs and requires a minimum of equipment and ability. Also, participation is not limited to any age group. This family outdoor activity is provided at eight of the basin's 48 developed recreation areas, with a total of 153 picnic sites available for enjoyment.

Over 2.7 million acres of land are open for hunting in the Dolores River Basin. Statistics obtained from the Colorado Division of Game, Fish and Parks indicate that deer hunting has remained nearly static during the 1956-65 period (Figure 8).

Average annual figures for this time period show that 7,700 hunters killed 7,681 deer, yielding a hunter success ratio of almost 100 or about one deer per hunter. Elk hunting in the Colorado portion of the basin,

DEER HARVEST
DOLORES RIVER BASIN
IN
COLORADO, 1956-1966



NOTE:
In 1966 only one deer per hunter, either sex, was legally bagged. This rule is currently in effect. As a result, the 1966 hunter success ratio dropped nearly 50 percent from the 1956-65 average ratio.

Figure No. 8

likewise, has been fairly stable. For the eight-year period of 1958-1965, an annual average of 1,670 elk hunters bagged 448 animals yearly for a 27 percent hunter success ratio.

Private recreation enterprise at Groundhog Reservoir

A two-deer license program was in effect for the Colorado portion of the basin until 1966. At this time the bag limit was dropped to one deer (either sex). As a result, the number of hunters declined to 5,813 while the total kill fell by nearly 50 percent. Consequently, the hunter success ratio dropped from the ten-year average of almost 100 to 53 percent. At the same time elk hunters were experiencing an average year (i.e., 410 elk were taken by 1,627 hunters for a 25 percent success ratio). Table 41 indicates that nonresidents were slightly more successful than residents in bagging deer and elk. Twenty-eight bear and 22 turkeys were killed in 1966 in the basin. Although six bighorn sheep licenses were issued for hunting in the new Lizard Head Pass Management Area, no trophies of the state animal were taken. Several antelope are known to exist southwest of Naturita along the Montrose-San Miguel County line, but no official game season has ever been declared in the basin. In 1962 and again in 1964 the Colorado Division of Game, Fish and Parks transplanted a total of 46 antelope in the Disappointment Valley. To date, the apparent success of stocking these animals has been marginal.

Table 41.--Big game harvest, Dolores River Basin in Colorado, 1966

Type of license	Number of hunters	Kill	Success ratio (percent)
Deer			
Resident	3,090	1,395	45
Nonresident	2,723	1,664	61
Total	5,813	3,059	53
Elk			
Resident	1,155	260	23
Nonresident	472	150	32
Total	1,627	410	25
Bear	n.a. 1/	28	-
Turkey	50	22	44
Sheep	6	0	0

1/ n.a. = not available.

Source: Colorado Division of Game, Fish and Parks

Winter Sports

Winter sports activity in the Dolores River Basin is focused on skiing. Normally, good ski surface conditions permit four months of skiing. Dallas Divide and Stoner are the basin's two ski areas; both are predominantly weekend ski areas. Dallas Divide, situated at a base altitude of 8,200 feet, is located 20 miles northeast of Placerville, along State Highway 62. This privately-owned ski area, which has a vertical drop of 800 feet, provides open slopes with five trails and one T-bar lift with a 450 capacity per hour. Stoner Ski Area, jointly owned by the Forest Service and the Sky Hi Ski Club, is located 15 miles northeast of Dolores. With a base altitude of 7,500 feet and 1,200 feet vertical drop, Stoner has four open slopes and two trails for skiing. Two T-bar lifts and one rope tow yield a rated tow capacity of 1,300 per hour. Both Dallas Divide and Stoner Ski Areas have been operating only a few years. The 1966 estimated visitation was 3,000 and 5,000 respectively.

Stoner Ski Area, upper Dolores River
(soil mapping unit 7)

Since 1965, snowmobiling has become exceedingly popular, and demand for this sport is expected to increase in the future. The Colorado Recreation Survey of 1967 ranked snowmobiling 36th most popular of 40 outdoor recreation activities for the entire state. However, more recent winter opportunities and events in the basin indicate that the popularity of this activity now surpasses ice skating, ice fishing, and sledding and tobogganing. High mountain passes, such as Lizard Head, and other snow-covered terrain at higher elevations support snowmobiling as late as May.

Economic Importance

To determine the economic importance that recreation contributes to the basin's economy, it was necessary to break recreation activities into four divisions: (1) vacation travel, (2) hunting, (3) fishing, and (4) skiing. An estimated $1.6 million was spent directly for recreation in the Dolores River Basin in 1966. Table 42 reveals that vacation travel or tourism, which includes participation in swimming, boating, camping, picnicking, and sightseeing, accounted for 59 percent of the total recreation expenditures. Hunting, mainly big game, contributed about $413,000

for 26 percent. Eleven percent and four percent are supplied by fishing and skiing. License fees for hunting and fishing are not included in these estimates because they are sent to the State Division of Game, Fish and Parks in Denver.

Table 42.--Recreation monetary values, Dolores River Basin in Colorado and Utah, 1966

Recreation category	Estimate of direct spending	Percent of total
	Dollars	Percent
Vacation travel	950,700	59
Hunting 1/	413,000	26
Fishing 1/	168,900	11
Skiing	72,100	4
Total	1,604,700	100

1/ Hunting and fishing estimates exclude the Utah portion of the basin.

Source: Data used in making these estimates are statistics published by the Colorado Division of Game, Fish and Parks and the Denver Hospitality and Recreation Center. Tourist travel studies by the Bureau of Business Research of Colorado University were also utilized.

Forest Products

Current Stand Conditions

Eighty-three percent of the sawtimber volume on the commercial forest land in the Colorado portion of the basin is in two species groups--spruce-fir and aspen. The spruce-fir type contains substantially more volume than the other three groups combined (Table 43).

Table 43.--Volume of sawtimber on commercial forest land by ownership and species, Colores River Basin in Colorado, 1967 (thousand board feet, International 1/4-inch log rule)

Ownership	Total all species	Aspen	Douglas fir-white fir	Ponderosa pine	Spruce-fir
National Forest	4,183,000	1,062,000	171,000	510,000	2,440,000
BLM	10,300	3,500	3,600	3,200	-
State and private	355,700	214,000	24,600	31,800	85,000
Total	4,549,000	1,279,500	199,200	545,000	2,525,000

Source: Developed by U. S. Forest Service

The sawtimber volume ranges from 2,700 board feet per acre for ponderosa pine to 17,600 board feet per acre for spruce-fir (Table 44). There is considerable variation in stocking rates for all types with conditions ranging from overstocked stagnated stands to very sparsely stocked areas.

Table 44.--Average sawtimber, pole, and sapling volumes on commercial national forest land per acre, Dolores River Basin in Colorado and Utah.

	Area acres			Sawtimber volume per acre	Poles and other volume per acre
	Sawtimber	Poles and other	Total	(Bd. ft.)	(Cu. ft.)
Spruce-fir	154,900	31,500	186,400	17,600	1,800
Ponderosa pine	190,800	36,100	226,900	2,700	100
Douglas fir-white fir	18,600	3,400	22,000	10,400	1,200
Aspen	180,600	20,400	201,000	2,500	1,000

Source: Developed by U. S. Forest Service

Current and Future Timber Products Supply and Demand

In 1970 the Forest Service and other agencies cooperated with the Office of Business Economics (OBE) and the Economic Research Service (ERS) to produce a national assessment of water and related land resources. One result is a projection of national timber supplies and demands to the year 2020, with intermediate projections for 1980 and 2000. The national projections were allocated to major water regions and to sub-basins. Use of the projections enables planners to identify the share of national demands which the sub-basin is expected to provide and to compare prospective supplies to the demands. In 1962, the base year of the assessment, the Dolores River Basin produced about 2 million cubic feet of industrial wood products. In that same year the estimated volume of supply of growing stock 16/ was 25

Table 45.--Supply of growing stock and production of domestic roundwood in 1962, with projections of supply and demand to 1980, 2000, and 2020, Dolores River Basin.

	1962	1980	2000	2020
	-- million cubic feet --			
Supply of Growing Stock 1/	25	37	40	40
Production and Demand of Domestic Roundwood 2/	2	42	58	66

1/ Net volume of growing stock trees removed from inventory by harvesting, cultural operations, land clearing or changes in land use.

2/ Logs, bolts, or other roundwood sections cut from trees for industrial or consumer uses.

Source: U. S. Forest Service and OBE-ERS data prepared for the National Assessment of Water and Related Land Resources, July 1970 and revisions of June 1971.

16/ Defined as the net volume of growing stock trees removed from inventory by harvesting, cultural operations, land clearing, or changes in land use.

million cubic feet. Beginning in 1965 the production of wood products had a sharp upturn (Figure 9). However, as shown by national assessment projections, the demand for timber products from the basin will exceed the supply by about 12 percent in 1980. The demand will continue to outstrip supply by a widening margin for the remainder of the projected time period if current levels of management, market prices, and other conditions remain constant or maintain current trends in change (Table 45).

Timber Industry

The average annual timber cut for the last five years (1964-1968) was 9.28 million cubic feet from stands on the National Forests. This amounted to 88 percent of the total timber harvested in the basin. The remaining eight percent was cut from BLM, and State and private lands (Table 46). Approximately 46 million board feet of sawtimber from the basin was used for wood products in 1968 (Figure 9). Of this about 92 percent came from National Forest Land.

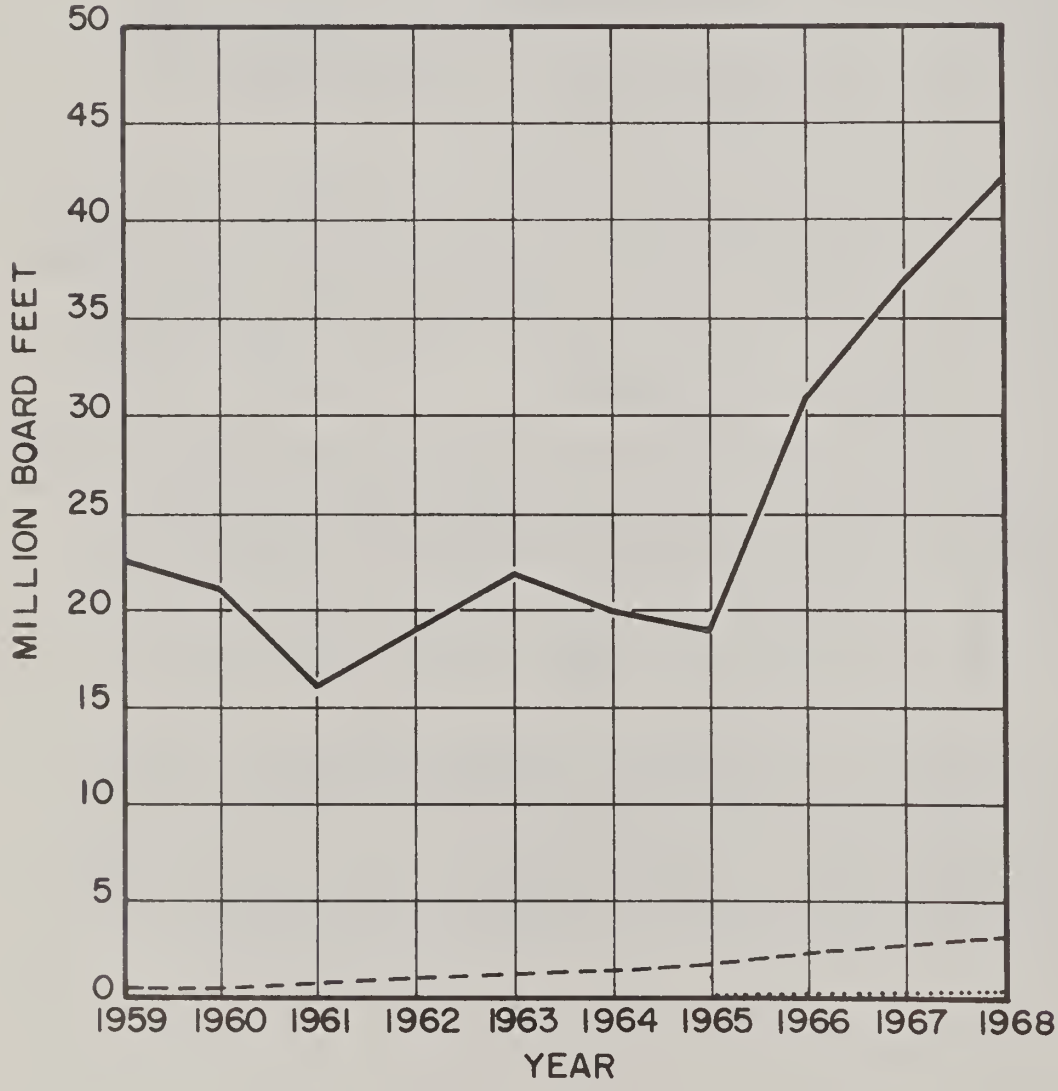
The basin's timber industries have been strongly oriented toward lumber production. However, increased amounts of wood are now being consumed outside the basin in the production of softwood plywood, hardwood pallets and matchsplints. An annual average of 329 timber sales and permits occur on National Forest land. In addition to the above products, the timber is used for cants, railroad ties, mine timbers, posts, poles, house logs, fuelwood, lath, and sawdust.

The plywood plant and sawmills near Dolores and the match plant at Mancos are harvesting considerable volumes of timber in the south portion of the basin (30-35 million board feet in 1968). Existing industries in the Montrose, Paradox, Norwood, Placerville, Naturita, and Hotchkiss areas are harvesting much of the timber in the northern part of the basin. Most of the timber-based activity is concentrated in areas where industrial enterprises are scarce. All lumber and other forest products for the entire basin are hauled by trucks.

The number of sawmills in the basin has declined from the peak of 1956, while average production for the remaining mills has risen. Sawmills are producing an average of about 1.5 million board feet each. Four sawmills in the basin produced three million board feet or over in 1967. In 1967 there were 12 active, primary wood-using establishments in the basin. Included in this number are ten sawmills and two post and pole plants.

TRENDS IN LUMBER AND OTHER TIMBER PRODUCTS OUTPUT BY OWNERSHIP CLASSES

DOLORES RIVER BASIN 1959-1968



National Forests
State and Private
Bureau of Land Management

Figure No. 9

Table 46.--Average annual timber cut and estimated net annual yield by ownership classes, Dolores River Basin, 1964-1968.

Ownership	Average Cut			Estimated Net Annual Yield		
	Growing stock 1/	Round-wood	Saw-timber	Growing stock 1/	Round-wood	Saw-timber
	(MM cu.ft.)	(MM cu.ft.)	(MM bd.ft.)	(MM cu.ft.)	(MM cu.ft.)	(MM bd.ft.)
National Forest	8.20	2.60	28.20	14.00	4.00	50.00
Public domain	0.04	----	0.20	-----	----	-----
State & private	1.04	1.60	2.25	3.25	1.83	7.12
Total	9.28	4.20	30.65	17.25	5.83	57.12

1/ Growing stock volume consists of all live trees 5.0 inches d.b.h. and larger; sawtimber is included as a component of growing stock.

Source: Developed by U. S. Forest Service

The new softwood lumber-pallet facility installed near Norwood is expected to produce 12 million board feet of lumber and other products annually starting in 1969.

Value of Wood Products

The stumpage value of the average 9.28 million cubic feet of growing stock harvested annually is about 278 thousand dollars. At local points of delivery the value of harvested roundwood and sawtimber is about 877.5 thousand dollars. The difference between delivered value and stumpage value is the value added 17/ by harvesting activities; it is estimated to be nearly 600 thousand dollars. The value of shipments from the twelve primary manufacturing plants averaged about 2.5 million dollars in the 5-year period, 1964 to 1968. The value added by manufacturing is obtained by subtracting the delivered value of harvested products from the shipment value. This is about 1.6 million dollars. Table 47 shows the estimated average annual product value, the total value added by each activity, and the portion of added value which is attributed to timber related activities.

17/ Because of data limitations the value added, as used in this report, included operating expenses and should be viewed as a gross approximation to its strict technical definition.

Table 47.--Estimated average annual value of product or service, total value added, and value added attributed to timber, in timber-based economic activities in the Dolores River Basin, 1964-1968.

Kind of timber-based economic activity	Dollars
Forest use and management	
Estimated value of stumpage cut (9.28 million cu. ft.)	$ 278,400
Harvesting	
Value of products harvested 1/	877,500
Value added in harvesting	599,100
Value attributed to timber by harvesting	599,100
Primary Manufacturing 2/	
Value of shipments from primary manufacturing plants	$ 2,500,000
Value added in manufacturing	1,622,500
Value added attributed to timber	1,427,800
Total attributed to timber	$ 2,305,300

1/ Value at local points of delivery.

2/ Plants and mills using logs or other roundwood as a source of material

Employment and Income

Timber-based industries play a rather important role in the basin's economy. In 1967, 79 full-time and 41 part-time people were employed in timber harvesting and primary timber manufacturing. If the two figures are taken compositely, the result is approximately equivalent to 100 man-years. For this group, total yearly wages were $516,500 or an annual average wage of $5,165 per worker in the forest products industry. Included in such employment are timber cutters, haulers, mill workers, and marketing people.

In 1967 an estimated 20 people were employed in forest management, most of them by the Forest Service. This total is more than doubled during the summer seasonal peak period. Converting summer seasonal employment to full-time equivalents brings average full-time employment close to 25 jobs per year. Annual salary estimates for this group were $175,000.

Collectively, 125 jobs were provided by the timber-based industry in the basin in 1967. This does not include secondary manufacturing of timber products. Installation of the new lumber-pallet facility near Norwood in early 1968 is expected to add another 50 jobs to this employment sector.

Salvaging aspen logs from road right-of-way clearing,
Taylor Mesa, San Juan National Forest

It is assumed that employment will increase along with production. Based on prospective supply projections, employment will more than double by the year 2020 (Table 48).

Table 48.--Estimated number of employees in timber manufacturing industries, Dolores River Basin in Colorado and Utah, 1967, 1980, 2000, and 2020.

Year	Grand total	Lumber and wood products			Timber harvesting and hauling	Forest management
		total	Sawmills and planning mills	Post and pole plants		
1967	125	78	67	11	27	20
1980	186	120	100	20	38	28
2000	235	163	135	28	40	32
2020	252	172	140	32	46	34

Source: Developed by USDA Field Party

Employment could increase three-fold if potential levels of production are achieved and additonal wood-using industries are established.

Mineral Resources Industry

Industrial Productivity

Chapter III (Natural Resources) points out the physical location and depositional aspects of the basin's mineral resources. It also emphasizes the fact that the Dolores River Basin is richly endowed in mineral resource wealth. Uranium and vanadium ores account for the principal mineral production valuation. Before the advent of the nuclear age, "complex" ores (a term commonly applied to ores containing two or more metals: silver, zinc, lead, copper, and gold) were the main metallic elements mined. Today these ores still are important to the economy of the basin.

Since the 1920's sporadic oil and gas exploration has occurred in the basin, but no substantial deposits of oil have been found from extensive wildcatting by oil companies. The U. S. Geological Survey estimates that four gas wells in northwestern San Miguel County (about ten miles northwest of Slick Rock) have a combined potential daily yield of 28.1 million cubic feet of gas. These gas wells are not presently operative but serve as an important portion of the state's 2,093 billion cubic feet of gas reserves.

Table 49 itemizes the number of active mines and mills in operation by county for the basin in 1966. Mines in Grand, Mesa, Montrose, and San Juan Counties are primarily uranium-vanadium, while those in Dolores, Montezuma, and San Miguel Counties produce perdominantly complex ores. In addition to the 126 Montrose County mines, a rock crushing operation and a coal strip mining area are located in that county. Of the six mills or plants in the basin, all process complex ores except for the two in Montrose County (Union-Carbide at Uravan and Foote Mineral Company at Naturita) [18/] which produce uranium oxide concentrate (U_3O_8) -- commonly referred to as "yellow cake." Both companies are also involved in the production of vanadium.

Table 49.--Mineral operations, Dolores River Basin in Colorado and Utah, 1966

County	Number of Mines	Number of Mills
Dolores	6	1
Mesa	29	0
Montezuma	1	0
Montrose	126	2
San Miguel	61	3
Total - Colorado	223	6
Grand	20	0
San Juan	20	0
Total - Utah	40	0
Total	263	6

Source: Developed from information provided by the Colorado State Bureau of Mines

Figure 10 shows the graphical distribution of three categories: the complex ores, uranium-vanadium, and other. The other classification includes coal and nonmetallic minerals such as stone, sand, and gravel. During the 1940's and early 1950's the complex ores ranked high in comparison with the other two groupings. But since the late 1950's, this category has been overshadowed by the production of uranium and vanadium.

18/ This mill is no longer operating.

PRODUCTION VALUE OF MINERAL RESOURCES DOLORES RIVER BASIN IN COLORADO AND UTAH, 1945-1966

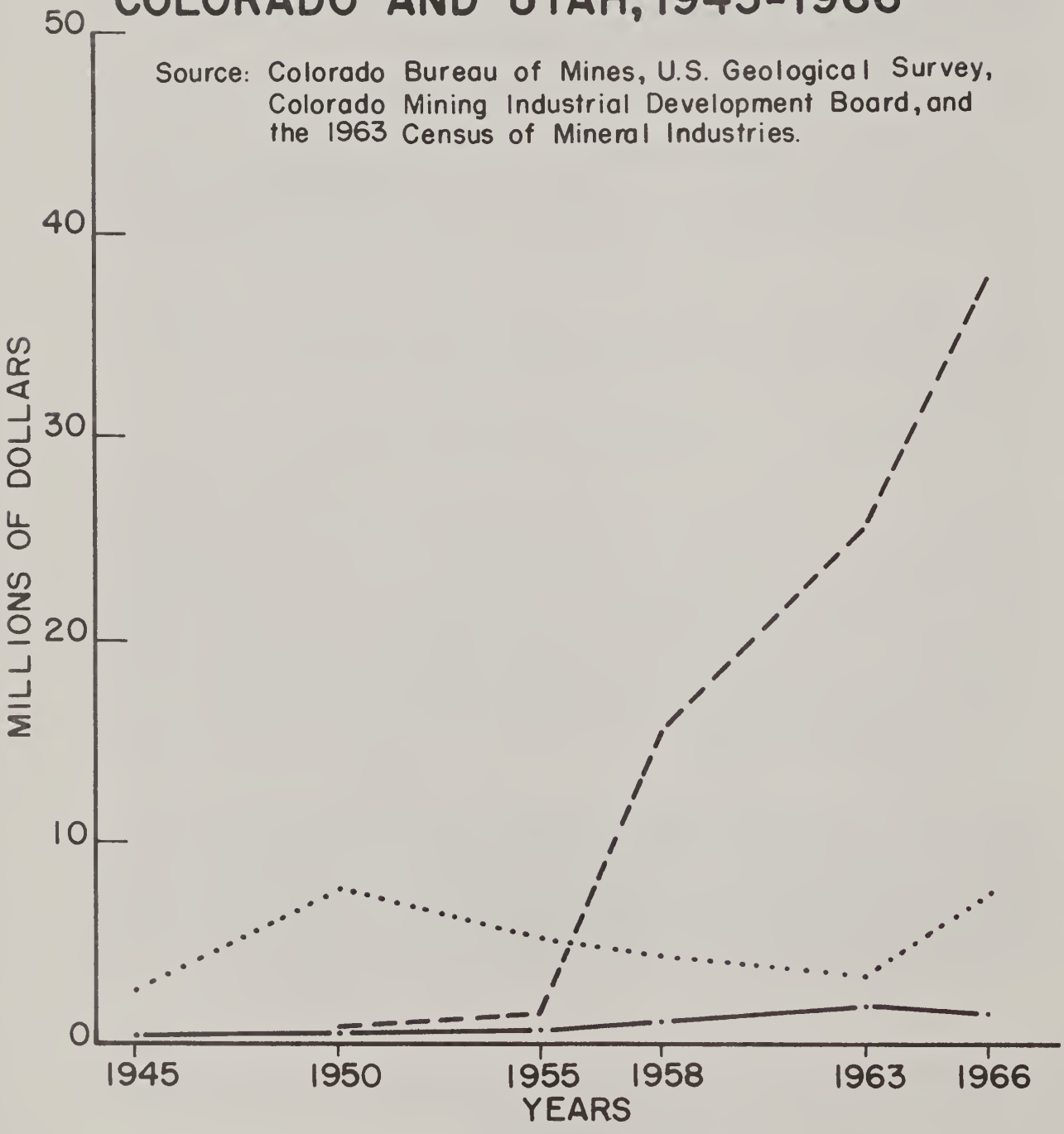


Figure No. 10

In 1958 the Atomic Energy Commission (AEC), as contractor of uranium for defense requirements for nuclear weapons of the U. S. Government, terminated all foreign uranium contracts and initiated a policy to acquire all future uranium from domestic ore reserves. The effect of this was to provide the domestic uranium industry with a substantial, continuing market through 1966. However, in 1962 the commission embarked on a stretch-out program which essentially continues existing contracts until 1973. THe main item of change in this stretch-out period is the lowering of the price of uranium oxide concentrate per pound from $8.00 to $6.70. Domestic peacetime use of uranium for electric-power generation has far exceeded the estimates of AEC officials. 19/ Obviously, this situation presents a favorable future outlook for those industries engaged in uranium production.

To a great extent vanadium production has been a satellite activity of the uranium industry, because vanadium comes from deposits of uranium-bearing sandstone in the Dolores River Basin. Vanadium is used principally as an alloy to control grain size, import toughness, and inhibit fatigue in special engineering, structural, and tool steels.

As such, this element has contributed to much improved steel alloy tools. Because there are no vanadium mills in the Dolores River Basin, uranium residues bearing vanadium are transported to mills outside the basin for processing.

Referring again to Figure 10, it is evident that the complex ore production has been relatively stable (ranging from a low of $2.6 million in 1945 to a high of $6.5 million in 1950) during the 22-year period, 1945-66. Likewise, the other category has been static too. Production values have averaged approximately $1 million annually.

In terms of 1966 production values, the uranium-vanadium category accounts for over 80 percent of the basin's productive capacity (Table 50).

Sixteen percent and three percent are produced by the complex ore and other classifications. This productive distribution (1966) on the basis of elements is fairly typical for the 1960's.

19/ In a 1962 report to the President, AEC estimated an annual U. S. nuclear domestic generating capacity of 40,000 megawatts by 1980. Now, in 1968, they have adjusted their earlier estimates to 145,000 megawatts -- an increase of 3.6 times the original estimate.

Table 50.--Mineral production value by element, Dolores River Basin in Colorado and Utah, 1966

Metallic minerals 1/	Estimated 1,000 dollars
Copper	1,652
Gold	651
Lead	3,004
Silver	802
Uranium	18,596
Vanadium	16,282
Zinc	4,402
Subtotal	45,389
Nonmetallic minerals	
Sand and gravel	443
Stone	106
Subtotal	549
Mineral fuels	
Coal	427
Total	46,365

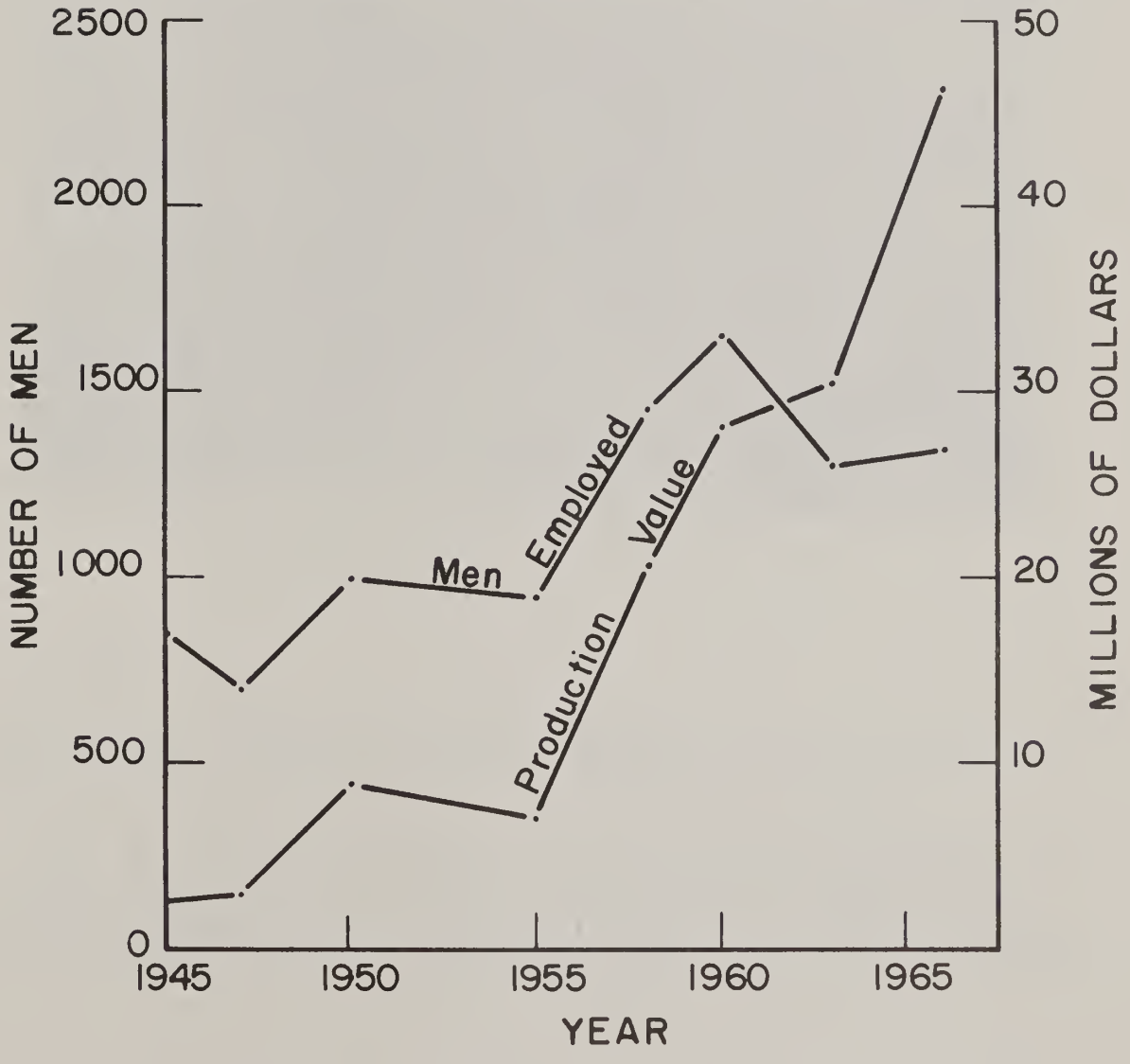
1/ Average prices are as follows: copper $.36 per pound, gold $35.00 per ounce, lead $.15 per pound, silver $1.29 per ounce, uranium $8.00 per pound, vanadium $1.40 per pound, and zinc $.14 per pound.

Source: Developed from information provided by the Colorado Bureau of Mines

Economic Considerations

Figure 11 compares the number of men employed in the basin's mineral resources industry with the total dollar value of mineral commodities produced from 1945 to 1966. Previous to the uranium boom, the mining employment averaged 900. After growing rapidly during the late 1950's, employment has declined from the peak 1960 level of 1,650 to a current estimate of 1,200. The average annual mining employment for the nine-year period, 1958-1966, was 1,400. Except for a slight dip in the early fifties, the value of mineral production has consistently expanded. From 1955 to 1966 the mineral production value soared to a sevenfold increase.

ESTIMATED EMPLOYMENT AND PRODUCTION VALUE OF MINERAL RESOURCES INDUSTRY DOLORES RIVER BASIN IN COLORADO AND UTAH, 1945-1966



Source: Colorado Bureau of Mines, U.S. Geological Survey, Colorado Mining Industrial Development Board, and the 1963 Census of Mineral Industries.

Figure No. 1

This phenomenal climb is attributed to uranium production. Thus, the uranium industry has directly contributed approximately 400 jobs in the Dolores River Basin and added an additional $40 million to the gross mineral production. Value added by manufacture in 1966 amounted to about $23 million.

Coal strip mining operation near Nucla

Future Outlook

The long-range outlook for the mineral industry in the Dolores River Basin is bright. Assuming no drastic changes in politics, economics, or technology, the general trends can be anticipated as follows:

(1) After being overshadowed by the uranium-vanadium industry for the last ten years, the production of complex ores is gaining impetus from increasing price levels brought about by greater demand for these metallic minerals. The U. S. Geological Survey reports that the complex ore reserves are adequate to sustain production at present rates for many

years, but unless large new deposits of these metals are found, they are not likely to resume their once-dominant role in the basin's mineral industry.

(2) Although uranium and vanadium reserves are only moderate, continued production of uranium oxide concentrate (U_3O_8) and vanadium oxide concentrate (V_2O_5) appears optimistic. The AEC's stretch-out program coupled with increasing private industrial use of uranium will continue to bolster the basin's strong mining economy.

(3) Notwithstanding an estimated coal reserve of three million tons of grade A bituminous, the local demand for this resource has dwindled in the last few years. However, the Colorado-Ute Electric Association forecasts that local and regional demands for electricity will increase considerably in the immediate future. The estimated need for coal to supply the electric power generation plant at Nucla is double the current production rate of 60,000 tons per year.

(4) As highways and roads are improved and general business activity expands, the demand for nonmetallic construction materials such as sand, gravel, and stone will continue to grow steadily at an estimated five percent per year.

V. WATER AND RELATED LAND RESOURCE PROBLEMS

Erosion Damage

Accelerated water erosion has caused major damage in the basin. Soil units 1, 2, and 3 (General Soil Map) have the largest acreages of moderate and severe erosion. 1/ The overuse of range resources during early development depleted vegetative cover in many areas. Also, fires destroyed cover in a few places. Reestablishment and recovery of vegetative cover in soil units 1, 2, and most of 3 have been slow because of the low annual precipitation, usually below 12 inches. Other factors affecting cover in soil unit 3 are steep slopes and rock outcrops. Soil unit 4 receives 12 to 15 inches annual precipitation. Soil units 5, 6, and 7 receive more than 15 inches precipitation and the depleted areas at many places have responded to good management practices and reseeding.

Gully and sheet erosion are prominent in soil units 1 and 2, with some in soil units 3, 4, and 5. Numerous gullies have formed in soil units 1 and 2 and are enlarging through continued erosion. These gullies range up to 30 feet in depth, 50 feet in width, and are one-fourth to one mile apart. A considerable amount of this damage is caused by runoff from adjacent areas, usually soil unit 3.

Erosion damage on irrigated land is not extensive. It is estimated that about 55 percent of the irrigated land is adequately treated for erosion control. About 50 percent of the rangeland in private ownership is receiving adequate treatment for erosion control.

Dry cropland areas are not extensive and an estimated 45 percent of the acreage is receiving adequate treatment. With inadequate cover or improper treatment water erosion is moderate. Wind erosion is slight to moderate on dry cropland that is used for growing beans.

Sediment Damage

Sediment production within the Dolores River Basin is governed by the interaction of a number of factors. They include geology, soils, runoff, climate, topography, ground cover, land use, upland erosion, and channel erosion and sediment transport. The impact of any single factor is

---

1/ Slight, moderate, and severe erosion conform to classes 1, 2, and 3 described on pages 260-267 of USDA Handbook 18, Soil Survey Manual.

changed by the combined effect of the others. Some of these factors such as geology and soils, climate and runoff, ground cover and land use, and upland and channel erosion are directly related and may be considered as paired influences. Their relative significance varies from place to place but can be predicted in a general way by combinations of soils and cover types.

Sediment, the product of erosion, is solid material that is being transported or has been moved from its site of origin. Damage from sediment in the basin has been minor. Probably most important is the contribution of suspended sediment to the Colorado River. About one-sixth of the sediment discharge of the Colorado River near Cisco, Utah, comes from the Dolores River Basin. 2/

The highest sediment yield rate, 1.0 to 3.0 acre-feet per square mile annually, is in soil mapping units 1 and 2 (General Soil Map) which constitute about 6.5 percent (192,000 acres) of the total acreage. Vegetation is sparse due to low precipitation and erodibility of the soils. Soil unit 3 has a yield rate ranging from less than 0.2 to 1.0 acre-feet per square mile annually but with such a large acreage (974,000 acres) the total sediment yield is large. Irrigated and dry cropland in soil mapping units 4 and 5 (about 1.6 percent of the basin, 48,500 acres) have a sediment yield rate of 0.2 to 1.0 acre-feet per square mile a year. Streambank and gully erosion produces the greatest amount of sediment. Spring snowmelt and high intensity summer rains produce runoff that is damaging to soil mappings units 1, 2, 3, 4, and 5, but the other mappings units are not seriously affected.

Floodwater Damage

Floodwater damage has been relatively minor because of the absence of high damageable values.

Floodwater damages are the result of two types of excess runoff. Damages are caused by snowmelt runoff in the early spring. Characteristically these floods produce large volumes of water over a period of several days or several weeks, but do not produce high peak flows.

2/ Chapter III - Water Quality

These spring snowmelt floods cause streambank erosion, deposit sediment on the land, erode low lying fields, damage cropland, and delay crop growth. Damages are also caused by summer thunderstorms which tend to produce flash floods in localized areas with high peak flows but low total volume of water. The erratic random pattern of these intense summer thunderstorms results in damage to cropland, other land and improvements, or to facilities such as roads, bridges, irrigation structures, and other improvements.

A total of approximately 24,000 acres is subject to floodwater and sediment damage from the flood that occurs on the average of once in 100 years. Most of the damage area is scattered throughout the basin and includes 23,780 acres of irrigated pasture, range, and native hay. The remaining 220 acres are urban land. Occasionally the towns of Dolores, Naturita, and Telluride receive damage.

Estimates of the Main Stem damages from the Dolores and San Miguel Rivers average $169,000 annually. Damages are about $84,000 for the smaller tributaries and upstream watershed areas.

Water Shortages

A major portion of the water supply occurs as snowmelt runoff during May and June. Total runoff is more than adequate to meet the needs. However, the major problem is the lack of adequate storage facilities to supply water at the proper time to meet the demand. Much of the land now irrigated is in short supply and needs supplemental water during the latter part of the growing season. Also, there are many acres of potentially irrigable land that are now being dry farmed or used as rangeland because of water shortages.

Land under irrigation during the 1943-60 period totaled 47,050 acres (Table 51). An estimated 24,650 acres were short of a full water supply with a period of shortage ranging from 45 to 60 days.

Irrigated land in the San Miguel Subbasin (29,200 acres) varies greatly in water supply. This subbasin has an average estimated short water supply area of about 16,400 acres (56 percent) with a period of shortage averaging about 60 days. The Nucla area has very little water short land (less than five percent) primarily due to the abundance and availability of water from the San Miguel River. The Norwood-Redvale area has a much larger amount of short water supply land as does the high mountain hay and pasture land in the Telluride-Dallas Divide area. The Gurley Watershed, in the Norwood-Redvale area, consisting of approximately 14,400 acres of irrigated cropland has an

Table 51.--Irrigated acreage, Dolores River Basin, Colorado and Utah, 1943-60

Subbasin	Irrigated cropland		
	Full supply land	Short supply land 1/	Total
	(acres)	(acres)	(acres)
San Miguel			
Colorado	12,800	16,400	29,200
Dolores Main Stem			
Colorado	9,100	5,750	14,850
Utah	500	2,500	3,000
Subtotal	9,600	8,250	17,850
Total	22,400	24,650	47,050

1/ Short water supply is land that runs out of irrigation water before the end of the growing season

adequate water supply available, however, storage and distribution facilities are inadequate. About 9,000 acres in this watershed is short of water after the end of July.

The Dolores Main Stem subbasin (17,850 irrigated acres, Colorado and Utah) varies in water shortage from about 80 percent short in the Gateway area to about 15 percent in the Dolores area. The West Paradox Watershed in the Dolores Main Stem Subbasin contains about 2,500 acres of presently irrigated cropland. Of this, 1,000 acres have a short water supply. The subbasin average short supply area is about 8,250 acres (46 percent) with a period of shortage averaging about 45 days.

Water storage and control facilities are the best means for providing adequate supplies of late-season irrigation water. Storage and regulation of spring and early summer snowmelt are prerequisites for elimination of problems connected with unstable irrigation water supplies.

Other shortages in municipal, industrial, domestic, and livestock water supplies are minor. Where they occur, they are not normally a result of quantity but rather of control and timing of water releases to meet demands. Individual needs of these water users will be described in a succeeding chapter of this report.

Water Quality Limitations

This basin is underlain chiefly by sedimentary rocks of Cretaceous age. The arid soils are not leached, particularly the shale derived soils. These shales and shale derived soils are a principal source of supply for the dissolved solid yields. The dissolved solids content of the Dolores River contribution to the Colorado River, Table 10, page III-41, represents about the midpoint of the value for the Upper Colorado Region (above Lees Ferry, Arizona).

Snowmelt flows are the better quality water. As the flows diminish, the salt content in parts per million goes up, generally reflecting ground water replenishment to streamflow rather than surface flow contributions. For this reason, water storage and stream regulation will stabilize the quality of water condition during the year and dampen the longtime fluctuations in water quality.

The U. S. Geological Survey has estimated the dissolved solids yield from 15,000 irrigated acres in the San Miguel Basin between Placerville and Naturita at 2.8 tons per acre per year. The weighted mean for the irrigated acreage of the Upper Colorado River Basin for which there are data is 2.4 tons per acre.

The soil and water conditions require a moderate amount of leaching where irrigation is practiced. Soils with low permeabilities should not be irrigated. Proper irrigation practices, including drainage, are stipulated requirements in order for irrigation to be successful.

The salt concentration in most irrigation water is not sufficiently high to be injurious to plant growth. Salt accumulations in the soil produce the injurious saline conditions. With increases in salinity of irrigation water, the tendency for salts to accumulate in the soil likewise increases.

The USDA Salinity Laboratory classifies irrigation water into four class ratings based on salinity hazard: (1) Low-salinity water can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability; (2) Medium-salinity water can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control; (3) High-salinity water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected; (4) Very high salinity water is not suitable for irrigation under ordinary conditions, but may be used

under very special circumstances. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt-tolerant crops should be selected.

In parts per million of dissolved solids the four USDA Salinity Laboratory classes become: (1) up to 160 ppm, (2) 160 to 480 ppm, (3) 480 to 1,440 ppm, and (4) over 1,440 ppm. Another common measure of water salinity is in terms of electrical conductivity in micromhos/cm (EC x 10^6). Using this scale the above classes become: (1) up to 250 micromhos/cm, (2) 250 to 750 micromhos/cm, (3) 750 to 2,250 micromhos/cm, and (4) over 2,250 micromhos/cm. The conversion factor to change conductivity to parts per million is: ppm = 0.64 x micromhos/cm for irrigation waters in the range 100 to 5,000 micromhos/cm.

The salinity hazard is the degree to which the salts will accumulate in the soil profile. It has been found that if a saturated soil-water extract is removed from the soil root zone and tested, the results will show a salt concentration in the order of three to ten times that of the original water used for irrigation. Using this approach to the salinity problem, tables of relative tolerance of crop plants to salt have been developed. These are values which represent salinity contents of the saturated extract associated with a 50-percent decrease in yield. In most cases this represents the limit to which salts can be allowed to build up in the soil root zones. These upper limits in micromhos/cm for some common crops are: field beans 4,000; wheat 10,000; corn 8,000; barley and sugar beets 16,000; alfalfa 6,000 to 8,000; and saltgrass 18,000. Specific tables of these values can be found in USDA Salinity Laboratory publications.

The salt content of the drainage water then is a part of the salinity hazard. It must be kept in the range which the crops being grown can tolerate as measured by the soil root zone saturated extracts. Where the salts accumulate in the root zones, additional irrigation water must be applied to reduce the salt concentrations by dilution. This is called the leaching requirement in the total water budget. Provision for drainage must be a part of this salinity control program if the salt concentrations are to be kept at safe levels.

Suspended sediment yield of this basin is in the low medium scale when compared to the Upper Colorado Region. Suspended sediment yield, as well as dissolved solids yield, is related to several factors including geologic formations. Soils from shale derived dispersed clay formations go into suspension as collodial matter easily. Soils within soil mapping units 1, 2, and 3, which are in the more arid sectors of the basin, are the higher suspended sediment yielding areas. Undeveloped soils and sparse vegetation both contribute to this situation.

Low base flows, suspended sediment, and dissolved solids content all contribute to poor trout fishing along the west edge of the basin. Of an estimated 800 miles of streams in the Dolores Basin, only half are being used for trout fishing because of these limiting factors. Low base flows account for poor fishing conditions in many of the otherwise desirable fishing streams.

Nonbeneficial Phreatophytes and Seeped Lands

A survey was made to determine the acres of nonbeneficial phreatophytes [3/] in the basin that could be removed and the land used for crop production. Most of this acreage is adjacent to existing cropland. Density of cover was also determined during the survey. The total of all cover densities inventoried was 1,665 acres (Table 52). Phreatophytes on national forest land are considered as beneficial and are excluded from the inventory.

Table 52.--Nonbeneficial phreatophytes and seeped lands, Dolores River Basin in Colorado and Utah, 1965

Vegetative cover	Colorado	Utah	Basin Total
	Acres	Acres	Acres
Very dense	35	0	35
Dense	290	0	290
Medium	975	95	1,070
Light	270	0	270
Total	1,570	95	1,665
Seeped lands	125	0	125

Source: Developed by USDA Field Party

The types of phreatophytes are cottonwoods, willows, saltcedar, sedges, rushes, and saltgrass. Cottonwoods are found in narrow bands in the lower reaches of the streams, but cover broad areas near Dolores,

3/ For this report, "nonbeneficial phreatophytes" are nonagricultural plants that obtain their water supply from the zone of saturation. These plants are considered to be of little or no apparent beneficial use such as erosion protection for streambanks, shade and cover for livestock, shade for picnic and campgrounds, and others.

Naturita, and Gateway. Willows along streams have invaded some wet hay meadows. Saltcedar occupies areas along the Dolores River at Bedrock and the confluence of the Dolores and Colorado Rivers.

Phreatophytes are important food and cover for wildlife. However, the eradication of those phreatophytes classified as nonbeneficial is not necessarily a critical factor in relation to wildlife habitat. Nonbeneficial phreatophytes could be replaced with agricultural crops, mainly hay and pasture. There is no widespread control of phreatophytes. Management recommendations for irrigated hay and pasture land have included practices that will remove or control encroachment of these plants on existing cropland.

One-hundred twenty-five acres of seeped land were also inventoried. This is land that is no longer used for cropland because of seepage from irrigation systems. Land still used for pasture was not included. Consumptive use of water by the phreatophytes and seeped land acreage has been estimated in Table 12, page III-47.

Forest Land

Present Losses Through Damage

About 100,000 acres of poorly stocked or non-stocked ponderosa pine stands exist. There is a problem in establishing natural reproduction due to regular droughts during the seedling germination period. In addition, deer, rabbits, porcupines, and mice find the seedlings palatable, and livestock trampling is common. The pines also must compete with several grass and brush species for growing space, with the pines usually losing. Because of these damages and obstacles, extensive natural stands or ponderosa pine are established only at 20 to 40-year intervals.

Aspen sawtimber stands are overmature and suffer heavy mortality from heart rot and other diseases related to decadence.

Aspen on logged areas is regenerated by profuse sprouts and suckers. This growth is subject to severe browse damage by deer and sheep.

Range and forest fires have occurred often in the basin. Some of these have been devastating as shown by ecological changes in cover type and other physical evidence. Minor range and forest fires have occurred since national forest protection and cooperative fire control were initiated. Although the area burned is small, significant damages result. The national forest portion of the basin averaged 27 fires annually for the five-year period 1963-1967. The average area burned by these fires was 49 acres (Figure 12).

FIRE OCCURRENCE & ACRES BURNED
1963-1967
NATIONAL FOREST LANDS IN THE DOLORES RIVER BASIN IN COLORADO

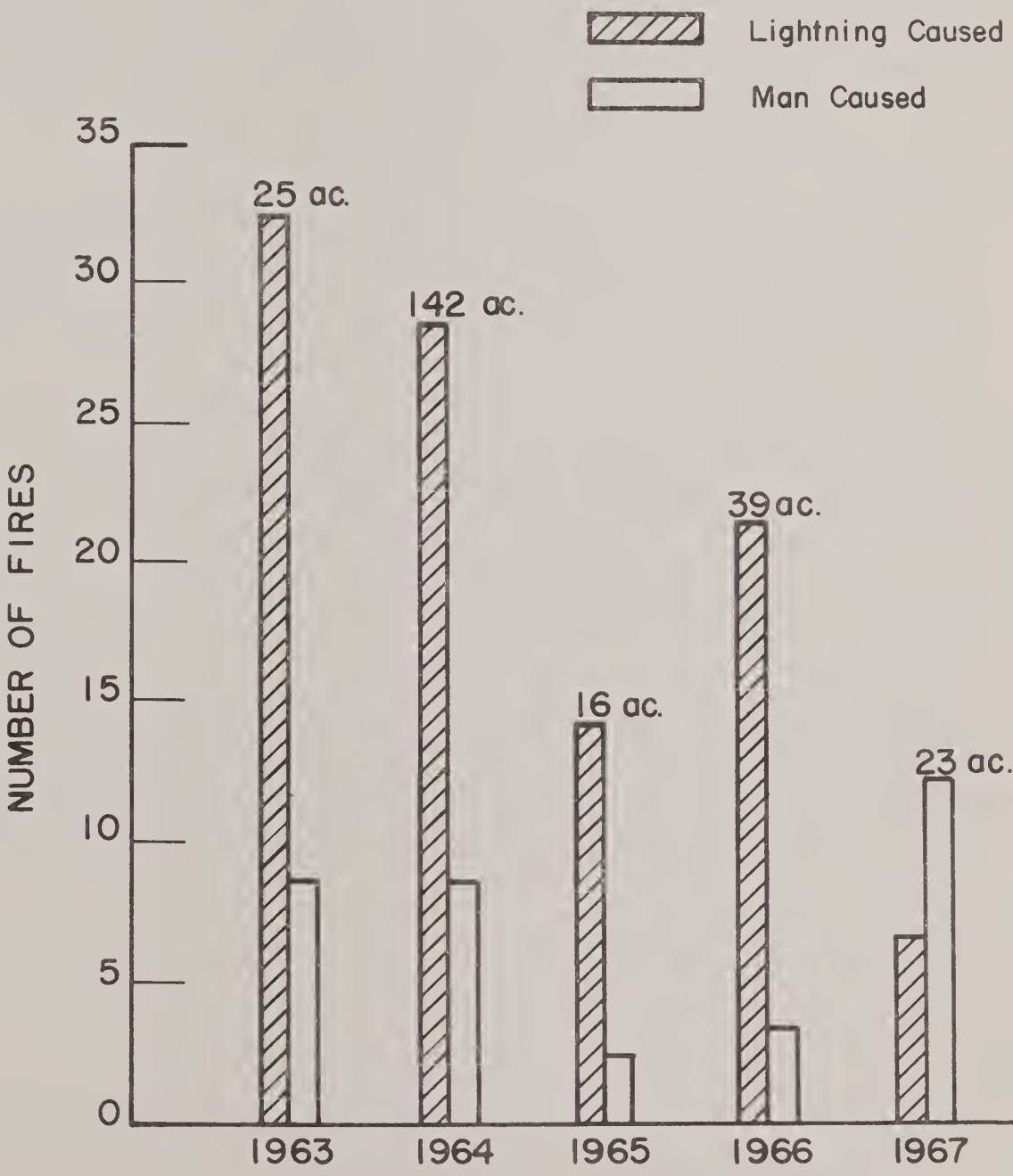


Figure No. 12

Damages which result from fire include direct mortality and loss of growth, increased insect and disease invasions, accelerated erosion and sediment production, hydrologic deterioration and increased flood runoff, forage and browse destruction, and aesthetic and environmental degradation. A major fire prevention problem is the increased recreational use, and a major control problem is the accumulation of logging debris and slash left on rights-of-way and reservoir sites.

An increase in man-caused fires is anticipated in the future. It is expected that fire occurrence will increase 50 percent by 1975, and double by 2000. Local sediment damage is a problem, especially on very steep south slopes in the low elevation forest land. Roads, trails, excavations, and overgrazed land on these areas cause accelerated sediment production. About 165 miles of gullies, 19,200 acres of accelerated sheet erosion, 114 miles of eroding streambanks, 275 miles of eroding roads and trails, and 470 acres of eroding mine areas have been inventoried on national forest lands.

Flooding and flood damages on forest land are minor.

Some developed recreation sites on national forest lands are being damaged by seasonal over-use. Campgrounds and picnic areas are used heavily during the summer months and have light spring and fall use. Soil compaction and reduction of vegetative cover is occurring, and these damages are in turn causing local erosion and sediment damages and loss of infiltration capacity of the forest floor and soil.

Fish habitat, particularly for trout, is being damaged by pollution from dissolved solids, water diversion and low base flows, and excessive amounts of suspended sediment from mine tailings, roads, grazing lands and other sources. About 400 miles of streams are being damaged. Big game and small game habitat is being reduced by land clearing for reservoirs, rights-of-way, new cropland, and recreation sites. Damage to terrestrial habitat occurs from overgrazing by domestic livestock, range and forest fires, and improper coordination with other resource uses.

Insect and disease damages are high on all forest stands and types. It is estimated that up to 50 percent of the gross annual growth of all timber may be lost or destroyed by insects or diseases. Bark beetles attacking large pines and spruces are the major insect problem. Dwarf mistletoe on ponderosa pine and butt rot and heart rot in overmature trees of all species are the major disease problems.

Problems Inhibiting Production of Economic Growth

About 97,000 acres of commercial forest land is occupied by overmature stands of spruce and fir. Stagnation, decadence, and excessive mortality from insects and diseases prevent these stands from achieving potential growth and production. Economic growth of timber-based industries is inhibited by the lack of production from these areas.

There are about 5,100 acres of non-stocked commercial forest land in the spruce-fir type, mostly on old burns lacking natural reproduction. This is a problem which limits timber production and inhibits economic growth.

About 40 to 45 percent (100,000 acres) of the commercial forest in the ponderosa pine type is so poorly stocked that little or no timber can be harvested. The condition of these stands is a serious problem affecting timber production and constraining economic development of forest products industries.

There is about 196,000 acres of overmature aspen sawtimber in the basin. Currently the net annual growth of these stands averages six cubic feet per acre. These areas have a potential net growth rate of more than 20 cubic feet per acre per year. This difference represents a large loss in production of wood and results in inhibition of economic growth.

About 9,000 acres of commercial forest land with good potential for ponderosa pine production is occupied by gambel oak. This oak is a tall shrub or small tree and is commonly called oakbrush. It often grows in dense thickets which invade ponderosa pine sites after repeated fires. The presence of oakbrush on commercial forest land is a problem affecting timber production and economic growth of the basin.

About 104,000 acres of commercial forest land is occupied by overstocked stands of seedlings, saplings and pole-sized trees. These stands are found in all forest types but are mostly in spruce-fir and ponderosa pine. The overstocked condition results in reduction of net annual growth, excess mortality, and unnecessary extension of time required for trees to reach merchantable size.

Access is a major problem hindering harvesting and management of the forest lands, especially in remote areas of the national forests.

Production and economic growth is increasingly hindered by the scarcity of skilled woods workers and lack of mechanization. The problem is compounded by unsuitability of much of the terrain for highly mechanized logging.

Problems which prevent full production and use of grazing resources on forest land are lack of adequate water developments, inadequate fencing, noxious and poisonous plants, invasion of grasslands by oakbrush and pinyon-juniper forest types, and poor stocking of desirable grasses and forage plants. About 95,300 acres of national forest grazing land has these problems. Inadequate fencing, water supplies, and stock distribution trails also inhibit full use of range resources.

Full use of forest recreation resources is inhibited by the lack of developed facilities and sites, a poorly developed network of roads, insufficient trails development, and lack of lakes, reservoirs, and other water developments.

Wildlife production is limited by habitat problems such as over-crowded timber stands (described above) which reduce browse and forage; poor stocking of grass and browse species on range and forest areas; and inadequate water supplies. Fisheries production is limited by lack of lakes, reservoirs, and insufficient base flow in many streams. On national forest lands inadequate food supplies is a problem on about 30,000 acres, and over-crowded timber is a problem on 10,000 acres.

Mining Areas

Uranium mining operation, Summit, Utah

Uranium mining in the basin has created hazards that could affect water quality. Spoil piles of uranium mills, located near Slick Rock, Uravan, and Naturita are a potential source of radiation, suspended sediment, and pollution of the streams. These spoil piles are unvegetated at the present time so wind and water transport the contaminating material to adjacent land and streams. Only the Uravan plant is now in operation.

Strip mining for coal in the Nucla area is providing fuel for the Nucla steam-electric generating plant. About 640 acres have been strip mined with more anticipated to meet the demand of the plant. The overburden is stripped to expose the coal for removal. The result is a landscape scarred with deep cuts and spoil banks of rock and debris. Rehabilitation of some of these areas to a near natural condition has been started. These areas will be a problem until sloping and revegetation can be completed.

VI. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

Protection and management of water and related land resources are interrelated and interdependent. Needs for developing these resources are based on the present and future activities and related problems.

Watershed Protection and Management - State and Private Land

The conservation treatment needs are expressed in acres of land needing one or more conservation practice treatments to overcome problems of erosion, soil condition, excess water or unfavorable climate. The treatment needs shown in Tables 53 and 54 were derived from the Conservation Needs Inventory (1966).

About 49 percent of the irrigated acres in Colorado (Table 53) have received adequate treatment. Five percent need cultural measures, 12 percent improved irrigation systems, and nine percent irrigation water management. Under pasture and range on irrigated land, one percent needs protection only while 24 percent need improvement only.

The Colorado dry farm cropland totals about 12,000 acres. Thirty-nine percent have received adequate treatment, seven percent need residue and annual cover, 15 percent need strip-cropping, terraces, or diversions, and eight percent need permanent cover. Under dry farm pasture and range, 24 percent need protection only and seven percent need improvement only.

The dry pasture in Colorado totals 29,100 acres. Thirty-four percent have received adequate treatment, 39 percent need protection only, and 27 percent need improvement only.

Rangeland is one of the main areas in need of watershed treatment. Of the 159,100 acres in range, 49 percent have received adequate treatment, 32 percent need protection only, 16 percent need brush control and improvement, 4,000 acres need reestablishment of vegetative cover, and 900 acres need reestablishment with brush control to make up the final three percent of the treatment for rangeland.

Approximately 27 percent of the 3,000 irrigated cropland acres in the Utah portion of the Dolores River Basin have received adequate treatment, (Table 54). Nine percent need cultural measures, 57 percent need

Table 53.--Conservation treatment needs on state and private lands, Dolores River Basin in Colorado

Treatment needed	Cropland: Irrigated	Cropland: Dry farm	Dry pasture	Range	Forest	land	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Treatment Adequate	22,000	4,700	10,000	78,100	343,300	70,800	528,900
Cropland Practices							
Cultural or management measures	2,200						2,200
Improved irrigation system	5,500						5,500
Irrigation water management	4,200						4,200
Residue and annual cover		800					800
Strip-cropping, terraces or diversions		1,800					1,800
Permanent cover		1,000					1,000
Pasture and Range Practices							
Needs protection only	600	2,900	11,300	50,900			65,700
Needs improvement only	10,700	800	7,800				19,300
Brush control and improvement				25,200			25,200
Reestablishment of vegetative cover				4,000			4,000
Reestablishment with brush control				900			900
Forest							
Establishment and reinforcement of timber stands					7,200		7,200
Timber stand improvement					20,600		20,600
Colorado Total	45,200	12,000	29,100	159,100	371,100	70,800	687,300

Source: County Conservation Needs Inventory (1966) - data adjusted to Dolores River Basin boundary.

Table 54.--Conservation treatment needs on state and private land, Dolores River Basin in Utah

Treatment needed	Cropland: Irrigated	Cropland: Dry farm	Dry pasture	Range	Forest	Other land	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Treatment Adequate	805	1,980	320	730	64,720	4,720	73,275
Cropland Practices							
Cultural or management measures	295	490				1,180	1,965
Improved irrigation system	1,700						1,700
Irrigation water management	200						200
Residue and annual cover		920					920
Strip-cropping, terraces or diversions		770					770
Permanent cover		240					240
Pasture and Range Practices							
Needs protection only			2,010	12,910			14,920
Needs improvement only			40	730			770
Brush control and improvement				300			300
Reestablishment of vegetative cover			330	1,050			1,380
Reestablishment with brush control				380			380
Forest							
Establishment and reinforcement of timber stands					1,370		1,370
Timber stand improvement					10,410		10,410
Utah Total	3,000	4,400	2,700	16,100	76,500	5,900	108,600
Total - Colorado and Utah	48,200	16,400	31,800	175,200	447,600	76,700	795,900

Source: County Conservation Needs Inventory (1966) - data adjusted to Dolores River Basin boundary.

improved irrigation systems, and seven percent need irrigation water management.

Utah dry farm cropland totals approximately 4,400 acres. Forty-five percent have received adequate treatment, 21 percent need residue and annual cover, 18 percent need strip-cropping, terraces, or diversions, five percent need permanent cover, and 11 percent need cultural or management measures.

Dry pasture and range in the Utah portion totals 2,700 acres. Seventy-four percent need protection only and two percent need improvement only, 12 percent need reestablishment of vegetative cover, and 12 percent have received adequate treatment.

Rangeland in Utah totals 16,100 acres. Five percent have received adequate treatment, 80 percent need protection only, five percent need improvement only, two percent need brush control and improvement, six percent need reestablishment of vegetative cover, and two percent need reestablishment with brush control.

The forest land in Utah totals 76,500 acres, with 85 percent having received adequate treatment. Two percent need establishment and reinforcement of timber stands, and 13 percent need timber stand improvement.

Flood Prevention

Because of the low population density and lack of high damageable values, floodwater damage has been relatively minor. The high water producing area is the mountainous headwaters of the basin, and snowmelt runoff is the principal source of water. Streams in this area are deeply entrenched, and the normal springtime flows spread over the flood plain areas. Since this is an annual occurrence, very little development has occurred on these flood plains. Farmers utilize these areas as wet meadows or pastures and as feeding grounds during the winter.

There is a need for reservoir storage and/or a channel system to remove the peak flows from two small drainages which cause damages to the town of Dolores.

In 1969 a cloudburst on Cornet Creek caused damages to Telluride. Using emergency funds, the Corps of Engineers enlarged the channel which runs through the northwest section of town. Flood plain zoning and additional control measures will be needed to protect future developments in the flood plain area.

Sediment Control

Total cropland amounts to slightly over two percent of the basin area. Irrigated land is expected to increase from 48,200 acres to 73,000 acres by 2020. Dry (nonirrigated) cropland is expected to decrease from 16,400 acres to 11,500 acres in the same period. At the present time most of this cropland is in erosion resistant close growing crops such as crested wheatgrass, pasture, alfalfa, or hay. Projected cropping patterns for this land do not show any appreciable change. More intensive use of conservation practices will lower both the present and potential volumes of sediment production on the land. However, as a percentage of the total basin sediment production, the effect would be minor because the major sediment producing areas are those other than cropland.

On the low elevation forest lands there is a special need to prevent or reduce accelerated sediment production from areas disturbed by roads, trails, excavation, and overgrazing.

The more sparsely vegetated rangeland is, and will continue to be, the higher sediment producer. Soil mapping units 1 and 2 are soils needing extensive treatment measures. Water intake rates of soils are directly related to the amount of both new and old vegetative cover present. Limited annual precipitation causes restricted growth and vegetative cover. The rain pattern includes occasional high intensity storms over limited areas.

With the low intake rates and a scarcity of dense growing plants to slow down surface water movement, silt production will be locally very high. Development of gullies allows for concentration of flows at even higher velocities and the acceleration of the erosion power of the water. Natural revegetation of the eroded area is slow, and the eroded areas tend to become cumulative under these conditions.

Disappointment, Paradox, and Big Gypsum Valleys are the larger land areas considered to have high sediment production. The needs of the basin, in regard to sediment control, are largely concentrated in these more arid rangeland areas.

Soil and water conservation practices are adaptable to the rangeland. The need is to conserve the precipitation in place in order that vegetation may make use of it. An increase in the amount of both live and dead vegetation increases the soil infiltration rate and thus lowers the amount of runoff. Proper livestock stocking rates and forage utilization maintain the essential plant cover to lessen the amount of soil movement.

Mechanical conservation measures include contour furrowing, pitting, contour seeding of adapted grasses, brush control, waterspreading, gully control, revegetation, fencing, stock pond construction, and installation of livestock water facilities at locations which will bring the desired protection of vegetative cover through proper distribution of grazing or better grassland management.

Range seeding on the contour, Bureau of Land Management
(soil mapping unit 1 in foreground)

Drainage Improvement

Proper irrigation practices, including drainage, are requirements in order for irrigation to be successful. The irrigated soils of the basin generally require a moderate amount of leaching for salinity control. The leaching requirement amounts to 30 percent in addition to the consumptive use requirement.

Drainage is needed not only to lower the depth to ground water where it has built up to harmful levels and to provide for the removal of water that is applied to leach excess salts out of the soil. Sufficient irrigation water must be applied to provide for both crop needs and the necessary leaching requirement.

Gurley Reservoir, irrigation water storage

Over-irrigation with cold water retards plant growth and lowers production. Seep areas, salt accumulations, and leaching of plant nutrients are also harmful effects of over-irrigation. It is estimated that 5,500 acres of irrigated land in Colorado need improved irrigation systems and 4,200 acres need conservation water management. In Utah, 1,700 acres need improved systems and 200 acres need conservation water management. Improved irrigation systems aid in the proper application of irrigation water and help prevent soil erosion. Improvements include such measures as: (1) reorganization of existing systems, (2) land leveling, (3) ditch lining, (4) erosion control measures, and (5) farm drainage. Conservation water management is needed to: (1) control erosion, (2) prevent excess water losses, and (3) time water applications to meet crop needs. The successful use of improved water management practices is dependent upon their application to adequate or improved irrigation systems. A dependable water supply, utilized in the most beneficial and economical manner, will produce higher crop yields that in turn will make improvements in water management facilities economically feasible.

Rural Domestic and Livestock Water Supply

People in rural areas depend on ground water for most of their domestic water needs, and quantities are generally adequate. Surface water also is used when ground water sources are unavailable. Most well water is obtained from shallow unconsolidated alluvial deposits along rivers and streams, and yields range up to 200 gallons per minute (gpm). Some wells are also drilled into consolidated rock, principally sandstone,

Salt content of the water supplies for irrigation is quite variable depending on the source, season, and flow conditions at the point of diversion. A need for drainage exists as a part of proper irrigation practices.

The needed work can be accomplished by individual and small group action type projects. PL 566 projects, especially those for agricultural water management, should include provisions for drainage. The same applies for the irrigated land management and treatment programs for the individual farms or ranches.

No new land is expected to be brought into production as a result of applying drainage practices.

Water Development Needs

Irrigation

There is an urgent need for more water storage facilities to help offset the wide fluctuations in yearly and seasonal agricultural water supplies and provide for late season irrigation needs. Many irrigation systems depend on direct diversion from small unregulated streams, and water shortages occur almost every year. There are three irrigated areas with short water supplies that could be served by project type development. These are the West Paradox, Gurley and Tabeguache watershed areas. (Project Location Map following IX-2). Approximately 16,500 acres would be benefited from project type development. Other areas that are small and isolated from potential projects could best be served by group action or individual developments. Agricultural productivity can also be increased by providing water to dry cropland, pasture, or new land suitable for irrigation, but not presently irrigated. An expansion of irrigated acreage would help stabilize the agricultural industry by improving the winter feed and forage base.

Another need is the installation of improved water management systems and practices to improve efficiencies and more fully utilize available water. At the present level of agricultural water use, the irrigated land needs over 14 percent more available water to satisfy the ideal crop irrigation requirement. Over 60 percent of the irrigated acreage is producing pasture, and a large portion of this land has inadequate water supplies. Seasonal water shortages contribute to the water management problems.

with yields varying up to 50 gpm. Well water through the basin generally has a moderately hard rating, but quality is otherwise satisfactory for most domestic uses. The present demand for rural domestic water is being satisfied from present sources, and future demand increases also can be met as needs develop.

Livestock water supplies are normally provided from developed surface water sources with some ground water augmentation. There are an estimated 2,000 stock ponds in the Colorado portion of the basin and 80 in Utah with an average size of about one acre-foot capacity. Projected increases in livestock numbers and more intensive management of range resources will require development of additional stock watering facilities.

Municipal and Industrial Water Supply

Municipal water supplies are generally adequate throughout the basin and present sources are considered sufficient to meet future needs. Five communities do have minor water problems, and some corrective action may be required as demands increase. Norwood depends on the Farmers Water Development Company (agricultural water) and No Name Creek, a tributary to the San Miguel River, for its water supply. Some shortages are experienced during dry spells, and sprinkling restrictions are occasionally imposed. A more adequate water treatment facility and a larger pipe line to the storage tank are needed to meet future increases in municipal demands.

Naturita needs to enlarge its water systems and provide more adequate sewage treatment facilities to meet expected growth. City water is taken from the San Miguel River. Quantities are generally adequate, but the water facilities need improvement.

Nucla's water system receives its water from the Colorado Cooperative Ditch Company (CCDC), and amounts are generally adequate. New developments around Nucla have not been tied into the municipal system, and there is a need to extend the present distribution lines to these areas. Over 1,000 taps are made along the CCDC ditch to satisfy the needs of people in the outlying area around Nucla.

Telluride and Rico have similar problems -- water shortages during the winter. Telluride obtains its water from Mill Creek with emergency supplies available from Cornet Creek. Occasional water shortages are experienced during the winter because some of the water mains are bled to prevent freezing.

Rico's water is taken from Silver Creek, and quantities are insufficient during long winter freezes. Improvement in collection, storage, and distribution systems of Telluride and Rico is needed to satisfy present and future increases in water use.

Industrial water demands in the basin are presently quite small with the Colorado-Ute power plant near Nucla consuming 3,200 acre-feet (90 percent) of the present use (3,400 acre-feet). The plant is a coal-fired electric generating plant and is known as the Nucla Station. It uses an unregulated, (no storage or river control facilities) direct diversion from the San Miguel River for its plant makeup and cooling water supply. Except for years of unusually good runoff, plant makeup water is not available in sufficient quantities for proper cooling, and generation must be cut back. Alternative methods of corrective action are being explored and a water supply system improvement will be made in the near future.

Other minor industrial water consumers are the uranium mill at Uravan and the lead-zinc mines at Telluride and Rico. Present water use is very small and future needs can be provided by development of existing resources.

Forest Land

Projections of economic activity for the nation, region, and basin show a need to increase timber production (Table 45, Chapter IV). In order to meet expected demands, timber supplies in the basin need to be increased 21 percent by 1980, 31 percent by 2000, and 39 percent by 2020.

Planting or seeding is needed to reforest and/or regenerate 100,000 acres of ponderosa pine and 5,100 acres of spruce-fir to reduce erosion and sediment production, improve hydrologic conditions, and contribute to satisfaction of timber needs.

About 195,750 acres of aspen sawtimber with an average age of 120 years now exist. These stands, which are an average of 40 to 50 years overmature, need to be harvested and regenerated. This will solve problems of decadence and disease, significantly increase timber supplies, and improve grazing and wildlife habitat.

Conversion of 9,000 acres of gambel oak to ponderosa pine is needed to help satisfy projected timber demands.

Final harvesting and regeneration is needed on about 97,000 acres of spruce-fir. This will help reduce excessive mortality from insects and diseases, contribute to timber needs, improve range and wildlife grazing, and reduce fire hazard through snag removal. Partial cutting rather than clear-cutting will reduce the need for artificial regeneration.

Thinning, weeding, release cutting, pruning and other cultural treatment is needed on about 104,000 acres of commercial forest land.

Fencing and grazing deferment is needed on logged aspen areas being vegetatively regenerated. Plantations of ponderosa pine, spruce, and fir also need grazing control to improve seedling survival.

Range seeding, proper salting, herding, control of noxious and poisonous plants, stock water development, and range fencing are needed to improve forage and meet demands for forest land grazing. There is also a need for closer cooperation between governmental agencies and private landowners in improving range management systems. On national forest rangelands type conversion, plant control, and revegetation is needed on about 95,300 acres. About 360 miles of fencing to control grazing, 480 range reservoirs and water holes, and 110 miles of stock distribution trails are needed.

Fire prevention and control measures are needed to reduce the number, size, and intensity of range and forest fires. Some of these needs are: (1) additional fire weather stations, (2) improved fire detection, (3) fuel reduction or elimination, (4) more effective prevention efforts, (5) more effective suppression techniques and more highly trained suppression teams including volunteer firefighters, (6) intensification of aerial fire control, (7) continuous updating and improvement of presuppression facilities, (8) increased study of fire control by weather modification, (9) hazard reduction along roads and access routes, (10) expansion of protection to private lands not now covered, and (11) improved coordination between suppression agencies.

Roads, trails, excavations, and overgrazed areas on low elevation forest land need erosion control measures, revegetation, and hydrologic stand improvement to reduce sediment production, improve water quality and improve infiltration. On national forest land sheet erosion control is needed on 20,350 acres; control is needed on 175 miles of gullies; 286 miles of abandoned roads and trails and 120 miles of streambanks need stabilization; and 475 acres of mined areas need erosion control.

There is a need for additional development of recreation sites to alleviate season over-use and resultant deterioration and to satisfy projected recreation demands. Projected additional needs are shown below.

Activity	Participation 1966	Additional Needs - 1980	Needs - 2000
	activity occasions		
Camping	85,700	70,900	257,500
Picnicking	176,100	81,000	270,900
Big game hunting	38,900	11,500	32,400
Small game hunting	15,400	5,300	14,200
Coldwater fishing	125,600	55,100	178,600
Skiing	24,700	23,600	100,300

There is a need for small cold-water impoundments for fishery use and an additional need for impoundments to provide augmentation of base flow during low-flow seasons. About 150 miles of fishing streams need treatment to stabilize banks and streamsides to reduce sediment loads and provide improved stream habitat.

Management needs of terrestrial wildlife habitat include wildlife openings and food patches, thinning of dense stagnated timber stands, openings and trailways in timber, and cover strips in cleared forest areas. On national forest land about 30,000 acres of wildlife food planting and patch openings are needed. Also, 10,000 acres of dense timber need thinning to improve wildlife habitat.

An adequate system of roads and trails is needed to properly develop, manage, and protect forest resources. Construction and reconstruction is needed on about 3,000 miles of forest access roads. Included is a network of low-speed, high-standard scenic roads to accomodate sightseeing and driving for pleasure demands. About 500 to 600 miles of recreation trails for backpack hiking, horseback riding, motorcycling and trail bike riding, and walking for pleasure are needed.

Outdoor Recreation

Capacity of Recreation Resources

Participation was previously discussed in Chapter IV and is stated in activity occasion terms. The availability of resources to support participation in a recreational activity has also been computed in activity occasions. This is based upon total resource (area) available for an activity multiplied by a standard. Traditionally, standards have been established by expert judgment involving evaluation of existing practical constraints. They are designed to indicate a norm or point of departure and to provide a basis for the development of local plans. However, planners should keep in mind that standards are sensitive to local conditions and are affected by topography, climate, population density, socioeconomic variables and attitudes of participants toward the type and amount of use. The recreation standards used in this report were obtained from the Colorado Outdoor Recreation Comprehensive Plan and uniformly applied to all rural areas.

Table 55 illustrates the relationship between participation, resource availability and capacity in 1966. Borrowing the methodology employed by the Comprehensive Plan, the following quantity of recreation resources were needed in the basin if it were to supply all of the listed activities:

Activity	Suggested Development
Swimming	85,100 sq. ft. surface water
Camping	250 campsites
Picnicking	70 picnic sites
Small game hunting	1,949,900 acres

A high quantity of resources are needed in order to preserve the quality of the resource and at the same time enhance the surrounding environment.

Future estimates of resource requirements needed were developed from the 1966 activity occasions for participation and resource availability. The difference in activity occasions indicates a deficit in providing recreation opportunities for swimming, big game hunting, and small game hunting. Tables 56 and 57 illustrate the comparisons of estimates on participation and resource availability for 1980 and 2000 respectively.

Table 55.--Comparison of activity participation, resource availability and capacity, Dolores River Basin in Colorado and Utah, 1966

Activity	Total basin participation (activity occasions)	Available resource to accommodate participation (activity occasions)	Capacity	
			Shortage (activity occasions)	Overage (activity occasions)
Swimming	89,100	4,000	85,100	
Cold water fishing	125,600	1,268,000		1,142,400
Warm water fishing	5,200	70,000		64,800
Boating	45,000	360,600		315,600
Camping	85,700	34,400	51,300	
Big game hunting	38,900	41,600		2,700
Small game hunting	15,400	8,400	7,000	
Picnicking	176,100	122,400	53,700	
Skiing	24,700	39,400		14,700

Source: Developed by USDA Field Party

In order that the quality of recreation resources be maintained, the following is a tabulation of how much of what might be developed given the standards and assumptions noted previously.

Activity	Suggested Development to Meet the Analytical Shortage	
	1980	2000
Swimming	139,000	275,000 sq. ft. surface water
Big game hunting	493,800	1,666,700 acres
Small game hunting	3,426,200	5,905,300 acres

The data above indicates a great need exists for developing these recreation resources in the basin. Given the 1966 standards for preserving the quality of the resource, the area projected for small game hunting development exceeds the total area of the basin for 1980 and 2000.

Table 56.--Comparison of projected participants, resource availability and capacity for outdoor recreation activities, Dolores River Basin in Colorado and Utah, 1980

Activity	Total basin participation (activity occasions)	Available resource to accomodate participation (activity occasions)	Capacity	
			Shortage (activity occasions)	Overage (activity occasions)
Swimming	143,800	4,000	139,800	
Cold water fishing	180,700	2,803,000		2,623,000
Warm water fishing	7,200	70,000		62,800
Boating	79,200	926,000		846,800
Camping	156,600	191,000		34,400
Big game hunting	50,400	42,000	8,400	
Small game hunting	20,700	8,000	12,700	
Picnicking	257,100	282,000		24,900
Skiing	48,300	85,000		36,700

Table 57.--Comparison of projected participation, resource availability and capacity for outdoor recreation activities, Dolores River Basin in Colorado and Utah, 2000

Activity	Total basin participation (activity occasions)	Available resource to accomodate participation (activity occasions)	Capacity	
			Shortage (activity occasions)	Overage (activity occasions)
Swimming	279,400	4,000	275,400	
Cold water fishing	304,200	2,803,000		2,498,800
Warm water fishing	11,000	70,000		59,000
Boating	164,000	926,000		762,000
Camping	343,200	517,000		173,800
Big game hunting	71,300	42,000	29,300	
Small game hunting	29,600	8,000	21,600	
Picnicking	447,000	522,000		75,000
Skiing	126,000	131,000		5,000

The high estimate of resource development for projected years are based upon variables affecting the participation as they may be interpreted today. Estimates of socioeconomic composition, leisure time, more access to resources, and tastes have changed with time and will continue to do so. In order that we may make better estimates of future participation, additional factors need to be identified, measured, and incorporated in our forecasting techniques.

Water Quality Control

In this basin man's effect on water quality is generally related to irrigation. Of the total discharge to the Colorado River - 460,200 tons of dissolved solids annually - 113,300 tons have been reported as being due to the activities of man. Forty-two thousand tons of this have been attributed to 15,000 acres of irrigated land between the gaging stations near Placerville and Naturita along the San Miguel River. On a population basis, domestic and industrial uses of water are estimated to produce 0.1-ton of dissolved solids per person annually in this

area, or a total of 1,100 tons. The remainder of the basin's irrigated land (33,200 acres) then accounts for the rest of the dissolved solids yield (70,200 tons) attributed to the activities of man.

Water of the Dolores River and tributaries above Disappointment Creek, and also water of the San Miguel River and its tributaries except near their mouths during periods of low flow, are suitable for domestic use. For the rest of the basin, many of the streams do not meet adopted domestic-use standards. The limiting factors might be high total dissolved solids content (over 500 ppm), over 250 ppm of sulfate (the maximum permitted), or more than 125 ppm magnesium (maximum allowable). The better irrigation water is the same water listed as being suitable for domestic use. Water from many of the smaller streams, especially those west of the Dolores River, are not suitable for irrigation because of unstable base flows and variable salt content. Most of the water presently used for irrigation is suitable for the purpose, provided proper irrigation practices, including drainage, are used. Irrigation water should not be applied on soils of low permeabilities.

Most of the water in this basin, except for a few of the streams in the headwaters, would require treatment for most industrial applications.

All of the known proposed storage features of irrigation developments will be helpful in control of water quality for water use in the basin. The storage features will be mainly for snowmelt runoff water which is low in dissolved solids. Release of the stored water would stabilize the quality of water condition during the year and dampen the longtime fluctuations in water quality. However, the overall effect outside the basin would be to slightly downgrade water quality in regard to dissolved solids. New land brought under irrigation would add an estimated two to three tons of dissolved solids per irrigated acre annually to the basin discharge. It is estimated that for each 100,000 acre-feet of water diverted annually from the basin (125 ppm average concentration of dissolved solids) that the weighted average concentration of dissolved solids increased 48 ppm in the Dolores River near Cisco, Utah.

Future control of the suspended sediment load of the basin will be largely related to application of range management practices. Range management practices are necessary to maintain a good protective vegetative cover. The Mancos Shale and Morrison Formation derived soils are silty or dispersed clay types and are erosive. A combination of these soils with low annual precipitation and poor vegetative cover results in a high silt producing area.

The anticipated increase in coal, uranium, and precious metal mining could cause some increase in both dissolved solids and suspended sediment discharge unless the operations are properly regulated. The uranium industry carried with it the risk of radioactive water contamination also.

Mine dump, Telluride

Growth of the recreation industry will depend on maintenance of an abundance of clean water. Trout fishing in particular is a recreational activity with high potential for future growth.

There are three uranium mill locations in the basin. These are at Naturita, Uravan, and Slick Rock. The Federal Water Quality Administration has evaluated the conditions and controls for pollution at these three sites.

The Slick Rock mill is not operating. At this site approximately 360,000 tons of tailings lie on a flood plain of the Dolores River. This pile extends to the stream edge and is subject to direct stream

erosion at high flows, erosion from pile runoff, and wind carriage to the stream. Except for a small trailer community of miners and mill maintenance personnel living a short distance west of the pile, there are no communities within a number of miles of this location. Suggested control measures include diking along the river, riprap to protect the dike during high flows, and at least minimal cover over the railings to prevent long term wind erosion. Some diversion ditching along the west side of the pile might be desirable.

The Naturita mill is nonoperating. Approximately 290,000 tons of tailings material are piled on the west bank of the San Miguel River near Naturita. The tailings rest on a low flood plain and extend to the river's edge. Wind carriage continually moves the material toward the river, and high river flows usually encroach directly onto the pile. Additionally, runoff in a draw which runs along the west and northwest edge of the pile picks up tailings. No significant wind carriage to a community is apparent here, although there are several private residences a short distance upstream from the pile. Suggested control measures include construction of an earth dike or a retaining wall along the river and along the draw to prevent wind carriage over the diking. Riprap along the dike would be needed to prevent erosion of the dike during high river flows.

The Uravan mill is operating. There are approximately three million tons of tailings accumulated at the site. Several thousand tons are piled adjacent to the San Miguel River, and the remainder is piled on a mesa well above the river. The pile along the river is susceptible to erosion by high river flows, while the pile on the mesa is not significantly affected by either surface runoff or drainage erosion. Air carriage of tailings to the community of Uravan is not virtually apparent, but undoubtedly some exists. Suggested control measures for the pile along the river should be carried out. Pushing the material away from the river's edge and constructing a well riprapped dike should provide adequate control. In the event of mill shutdown, control measures to insure the stability and permanency of the mesa pile should be considered.

There is a need for containment and stabilization of these tailings for at least 1 600 years (radium^{226} has a half-life of 1,620 years, and thorium^{230} has a half-life of 80,000 years). Containment and stabilization of the tailings is a continuing need during operations. Permanent protection is needed after the mines and mills have been shutdown. Three types of hazards are associated with these tailings, (1) water erosion, (2) wind erosion, and (3) ground percolation of leached material. The owners of all inactive piles have submitted plans for compliance to Colorado regulations.

VII. EXISTING WATER AND RELATED LAND RESOURCE PROGRAMS

USDA Projects and Programs

PL 566 Projects

Public Law 566, 83d Cong. 1954 as amended, established the Watershed Protection and Flood Prevention Act. This act provides for technical and financial assistance by USDA to state or local organizations for land treatment, flood prevention, irrigation water management, municipal or industrial water developments, and recreation, fish and wildlife developments on watersheds up to 250,000 acres. SCS has administrative leadership for providing cooperative federal assistance to local organizations in planning and implementing small watershed projects. Technical assistance, cost-sharing and long-term credit are the main contributions provided by USDA in the development of PL 566 watershed projects.

Small watershed projects are initiated by local organizations such as soil conservation, watershed, conservancy, drainage, irrigation or flood control districts. Soil and water conservation measures on the land must precede installation of structures. Flood prevention, agricultural water management and irrigation system rehabilitation, and recreation development are eligible for federal cost sharing while non-agricultural water management measures such as municipal water development are paid by the local interests.

There are no completed PL 566 projects in the basin although four projects are considered potentially feasible, and are in various stages of analysis and development. (Information is summarized in Chapter IX).

Another project possiblity is a proposal by the Montezuma Valley Irrigation Company (MVIC). This company diverts water from the Dolores River for use in the San Juan River Basin. A tentative watershed application has been filed on this project which would include water storage facilities in the Dolores River Basin. Sites for these facilities are located near the Bureau of Reclamtion's Dolores Project (Project Location Map, following pg. IX-5). Plans for both the MVIC watershed project and the Dolores Project are not far enough advanced to determine the interrelationships of the two projects. The MVIC could benefit from both projects. For this report the watershed project is considered as an alternative and/or a supplement to the Dolores Project. Features of the watershed project include two reservoirs of about 8,000 acre-feet each. One reservoir would be located on Beaver Creek (a tributary to

the Dolores River) with a diversion canal to Cottonwood Creek, a tributary to the Dolores River above Dolores. Water would then be taken from the Dolores River by the existing diversion at Dolores for use on irrigated land in the San Juan Basin near Cortez. The second reservoir would be located on Bear Creek, a tributary to the Dolores River above Dolores. Both reservoirs would supply supplemental irrigation water for short supply land in the Cortez area. Benefits from this development would primarily be derived through agricultural water management because flood control problems on these tributaries are presently very minor. (The San Juan River Basin will cover the benefits resulting from these proposals.)

Beaver Creek intake, Gurley Watershed
potential PL 566 Project

PL 46 Program

The Soil Conservation Service (SCS), the technical soil and water conservation agency of the U. S. Department of Agriculture, was created by the Soil Conservation Act (Public Law 46, 74th Cong. 1935). The primary job of the SCS is assisting land owners and operators, individually or in groups, with conservation work on the land. The objectives of the SCS are to: (1) achieve land use adjustments and treatment to conserve land and water resources, (2) reduce flood hazards and sedimentation, (3) assure efficient long-term use of soil and water, (4) establish a more permanent and stable agricultural industry, (5) assist in developing outdoor recreation areas, and (6) otherwise aid in the orderly development and prosperity of rural areas. These objectives are locally adapted and implemented through soil conservation districts that are legal subdivisions of state government. There are two districts in the Utah portion of the basin, servicing all of the area and six districts in Colorado, servicing over 97 percent of the area.

Sprinkler irrigation, West Paradox Watershed
(soil mapping unit 2)

Typical conservation practices installed in the basin with SCS technical assistance include: (1) brush control and range improvement, (2) conservation cropping systems, (3) crop residue management (includes crop residue use and stubble mulching), (4) irrigation system development and water management, (5) floodwater retarding and diversion structures, (6)

streambank protection and channel improvement, (7) stock watering facilities and trails, (8) fishpond management, (9) woodland harvesting, (10) proper grazing use of rangelands and grazable woodlands, (11) terracing and drainage, and many others. All these practices are basic to, and a necessary foundation for, better utilization of soil and water resources.

Cooperative Snow Surveys

The Soil Conservation Service has conducted snow surveys in the basin since 1936. Information collected by these surveys (taken annually from January to June) is used to prepare state and regional estimates of future water supplies. Forecast information makes it possible to plan ahead for efficient use or control of water for irrigation, power production, municipal and industrial demand, flood control, and recreation. Reports containing snow survey data are distributed to cooperating federal, state, private, and other agencies having a need for basic data and forecasts.

There are five snow courses and three soil moisture stations in the basin, all in Colorado. Soil moisture, as related to the amount of water the soil will absorb from melting snow, is also important in predicting streamflow. Basic soil moisture measurements have been taken three to four times a year since 1959. These data contribute appreciably to the reliability of streamflow forecasts. The basin receives relatively large quantities of snow, so forecasts, based on the water content as determined by snow surveys, have been dependable.

Agricultural Stabilization and Conservation Service

The Agricultural Stabilization and Conservation Service (ASCS) administers programs that provide cost-sharing to farmers and ranchers for conservation practices of public benefit. One program, the Rural Environmental Assistance Program (REAP) 1/ has been developed to: (1) provide enduring conservation benefits on land where conservation practices are applied, and (2) share costs with farmers or ranchers on satisfactorily performed conservation practices (federal share is normally about 50 percent). Costs are usually shared on practices that farmers and ranchers would not normally carry out without program assistance. County Agricultural Stabilization and Conservation Committees help coordinate REAP with the objectives and activities of local conservation districts.

1/ Formerly known as the Agricultural Conservation Program (ACP).

The SCS and Forest Service (FS) are responsible for the technical phases of many ACP practices. These responsibilities include: (1) need and practicability determinations, (2) site selection, (3) design and layout assistance, (4) supervision of installation, and (5) performance certification of installed practices. ACP cost-shared practices in the basin are coordinated through ASCS county committees and include: (1) establishment of permanent protective cover on range and farm land, (2) improvement and protection of established cover, (3) systems for the conservation and disposal of water, (4) protection of soil from wind and water erosion, (5) establishment of wildlife habitat, and (6) special conservation needs as determined locally.

Other programs administered by ASCS in the basin are: (1) The Feed Grains and Wheat Program initiated in 1962 that provides diversion and price support payments to farmers who shift land from grain production to conservation uses, and (2) The Price Support Program that provides loans, purchases, and payments to help maintain the prices of grains, beans, and wool.

Farmers Home Administration

The Farmers Home Administration (FHA) was established to help rural people and small communities develop their resources and solve their problems through a variety of loan programs. The type and amount of loan depends on the needs of the borrower. Any one of the following can be made to qualified individuals, associations, cooperatives, or public bodies: (1) farm ownership loans, (2) economic loans, (3) grazing loans, (4) operating loans, (5) rural housing loans, (6) water development and soil conservation loans, (7) watershed loans, (8) financial assistance loans, and (9) recreational enterprise loans.

SCS cooperates, as requested, with FHA by reviewing technical phases of loan applications that deal with soils information, engineering design, and layout and related soil or water problems.

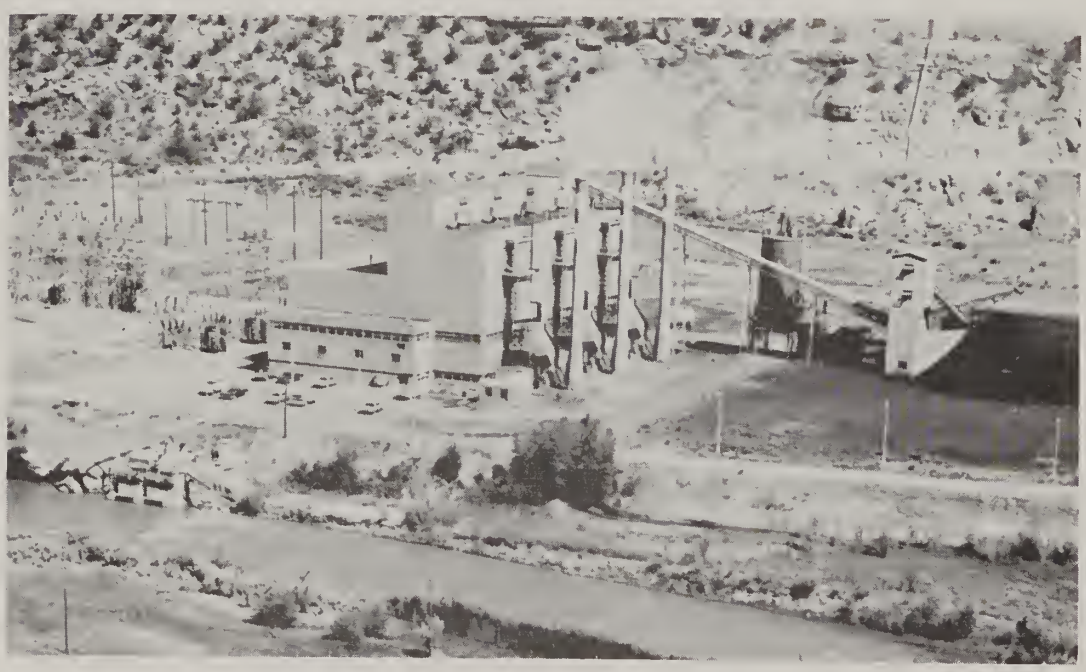
A recreational enterprise loan of $88,000 was used by the Sky Hi Ski Club to help develop the Stoner Ski Course (Project Location Map) at Stoner. The improvement work included overhaul and extension of the T-bar lift originally built in 1954, extension, widening and grooming of the three main runs, a new T-bar lift to replace the rope tow, and relocation of the warming hut. A recent loan application for improvement and remodeling of the warming hut facilities has been submitted to FHA. This work will be completed by 1980 and is discussed in Chapter IX.

Farmers Home Administration also is providing grants to other organizations for the preparation of comprehensive county plans for sewer and water systems in all Colorado counties in the basin. If other agencies such as the Department of Housing and Urban Development (HUD) can provide additional funds, the comprehensive County Plan will be expanded to cover all phases of county planning.

Rural Electrification Administration

The Rural Electrification Administration (REA) administers two loan programs for: (1) rural electrification systems and power generating facilities, and (2) extension and improvement of rural telephone service. There have been no telephone improvement service loans made in the basin.

Loans for rural electrification are made to cooperatives, public utility districts, municipalities, and power companies to finance generating, transmission, and distribution systems for providing electricity to rural areas without central station electric service. The Colorado-Ute



Industrial water use, steam electric
power plant near Nucla

Electric Association is a "super co-op" made up of approximately 16 Rural Electric Association distribution cooperatives, two that serve consumers in the Dolores Basin. The member consumer-owned co-ops buy power from the "super co-op" at wholesale rates and in turn distribute it to consumers at retail rates.

Colorado-Ute Electric Association recently completed (1959) a $9 million coal-fired steam-electric generating plant near Nucla. A REA loan was used to finance the 37.5 megawatt facility known as the Nucla station, that began commercial operations November 2, 1959. Power produced at the Nucla Station serves REA cooperatives in the Dolores Basin through a $4.5 million transmission and distribution network, also REA financed. Since the Hayden Station (Yampa River Basin) went on the line in 1965, the Nucla Station has been used as backup, providing peaking power at high demand periods of the day. The present peak power output of the Nucla Station is 39 megawatts. A minimum amount of coal is used (50,000-70,000 tons annually) because of the operational characteristics of the plant.

REA also has a potential loan possibility for the projected coal-fired steam-electric generating plant near Naturita. The plant would be a multimillion dollar investment by the Colorado-Ute Electric Association, capable of producing 750 megawatts of electricity. REA would help finance and administer the loan through its rural electrification systems program. Development of this facility will probably take place in the 2000-2020 time frame and is not considered as part of the early action program.

National Forest Development and Multiple Use Programs

Water Resources

National Forest watershed management programs include these measures scheduled for completion in the next 10 to 15 years: 7,600 acres of sheet erosion control, 10 miles of gully control, stabilization of 20 miles of streambanks, 50 acres of mine restoration, 25 acres of treatment for water pollution abatement, and restoration of 40 miles of eroding abandoned roads and trails (Table 57). These measures are primarily designed to maintain or improve water quality through prevention or reduction of sediment production. On the average, 17 percent of the problem areas identified in Chapter V will be treated; the range is from 5.7 percent for gully problems to 37.3 percent for sheet erosion problems.

Table 58.--Land treatment and structural measures currently planned under existing programs for the Grand Mesa-Uncompahgre, Manti-LaSal, and San Juan National Forests, Dolores River Basin, Colorado and Utah.

Item	Unit	Amount
Range revegetation - plant control and type conversion	acres	55,400
Range management - stock distribution trails	miles	65
Range management - fences	miles	160
Range management - water development	each	270
Reforestation and afforestation - planting and seeding	acres	22,700
Timber management - release, weeding, thinning and pruning	acres	39,050
Fish habitat improvement - streams	miles	4
Fish habitat improvement - lakes	acres	0
Wildlife habitat management - waterfowl habitat development, shallow water impoundments, and potholes	acres	20
Wildlife habitat management - establish forage plants and release wildlife food plants	acres	15,535
Wildlife habitat restoration and development - protect key areas by fencing	miles	50
Trail construction and improvement	miles	435
Road construction and improvement	miles	1,585
Roadside observation sites	each	140
Develop and control road sites	acres	360
Road, trail, and stock driveway bridges	each	7
Erosion control:		
Gullies	miles	10
Sheet erosion	acres	7,600
Abandoned roads and trails	miles	40
Streambank stabilization	miles	20
Mine restoration, control mining activities	miles	50
Water pollution abatement	acres	25

Source: Developed by U. S. Forest Service from Project Work Inventory data.

Another management objective is to increase the quantity and extend the delivery period of water. Management plans are prepared for four municipal watersheds--Waterfall Creek and Mill Creek in the Uncompahgre National Forest and Dolores River and Silver Creek in the San Juan National Forest.

Use of other resources is coordinated with watershed management, especially when manipulation of the vegetative cover is involved. Planned measures benefiting watersheds include range revegetation and type conversion as 55,400 acres, 160 miles of range fence to protect problem areas and newly established vegetation, and reforestation and afforestation of 22,700 acres (Table 57). In addition, thinning, release, and weeding planned primarily to benefit timber resources can have a secondary effect of increasing water quantity by reducing evapotranspiration.

Timber Resources

Timber is an important product of the national forests and, as projections in Chapter IV indicate, increasing demands are expected in the future. Timber management activities planned under existing programs include up-to-date inventories on all national forest lands; better sale preparation and administration; reduction of insect and disease losses by 50 percent; improved utilization of available timber on sale areas and from conversions and other clearings; better accessibility by constructing 1,585 miles of roads and seven bridges; release, weeding, thinning and pruning on 39,050 acres; reforestation and afforestation on 22,700 acres of land; reduction of fire losses; and continued research to improve genetic characteristics of trees and provide better silvicultural practices (Table 57). Achievement of these planning goals in the next 10 to 15 years will have some effect on timber supplies in the 1980-1990 period, but most will come in 2000 to 2020 and beyond.

Projections presented in Chapter IV indicate a 5 million cubic foot deficit of timber supply over demand in 1980. Most of this deficit can be eliminated by reducing insect, disease, and fire losses and improving utilization efficiency. About 70 percent of the year 2000 deficit can be provided by the measures outlined above, and in 2020 about 60 percent of the deficit can be eliminated.

Range Resources

The development and management activities planned under existing programs are: complete allotment inventories and management plans for

all national forest land; revegetation, plant control, and type conversion on 55,400 acres; and construction of 160 miles of range fence, 65 miles of stock distribution trails, and 270 stock water developments. Implementation of these measures could increase the capacity for grazing domestic livestock on national forest range by about 25 percent. This is about half of the potential increase which could be achieved by full development and management of the grazing lands.

Recreation Resources

Most of the outstanding natural attractions and potential outdoor recreation areas are in the national forests. It is the objective of the Forest Service to develop and manage the recreation resources to meet the demand in terms of kind, quantity, and quality. Current Forest Service programs are adequate to supply projected outdoor recreation sites for most land-based activities through 2000. Some planned measures are 435 miles of trail construction and improvement; 1,585 miles of road construction and improvement mentioned previously; and 1,140 roadside observation sites, vista points, and scenic turnouts.

Fish and Wildlife Habitat Resources

Wildlife and fish resources attract many visitors, and this use is expected to increase. The resources are considered adequate to meet current demands in spite of reductions in the amount and quality of habitat. The Forest Service program is designed to enhance wildlife and fishery resources, restore lowered quality, and mitigate losses from development and land use changes.

Measures planned for the next 10 to 15 years include 4 miles of stream habitat improvement; 20 acres of waterfowl habitat and shallow water impoundment; establishment and release of wildlife forage plants on 15,535 acres; and 50 miles of fencing to protect key wildlife areas. The watershed programs which reduce erosion and sediment will have a favorable effect on fisheries as water quality is improved or maintained.

Cooperative State-Federal Forestry Programs

The regional foresters and the state foresters cooperate in a number of programs in the basin designed to promote better management and protection of state and private forest land. In Colorado the Cooperative Forestry Programs are administered by the Colorado State Forester. The Colorado State Forester is attached to Colorado State University

which operates under the authority of the Colorado State Board of Agriculture. In Utah the Cooperative Forestry Programs are administered by the Utah State Forester who is in the Section of Lands of the Utah State Department of Natural Resources.

Cooperative Fire Control and Prevention

In Colorado and Utah the state foresters assist each county in making wildfire plans, purchasing equipment, organizing fire-fighters, and training. Suppression of fires is performed primarily by the counties; technical assistance is furnished by the state forester. The protection goal is to limit the annual burned area to one-tenth of one percent (0.001) or less of the protected area.

Good progress is being made in providing adequate fire protection for the private, state, and other non-federal land in the basin under the cooperative protection program. Work also is being done to reduce hazardous fuel conditions to minimize the chance of large fires developing and spreading to high-value areas.

Cooperative Forest Management

Through the Cooperative Forest Management Program, the federal government shares with Colorado and Utah the cost of assisting private woodland owners, loggers, and processors of forest products. The program provides technical guidance in the multiple-use management of woodland resources. Owners are encouraged and assisted to make the best use of their opportunities to grow timber and other forest crops, and to make the best use of their woodland for other purposes. Loggers and others harvesting forest products are assisted in improving their methods and equipment. Processors are assisted in improving their efficiency, the quality of their products, and their markets.

The Cooperative Forest Management Program in the West is relatively new and small in relation to many southern and eastern states. It will grow and serve as the pivot around which other state-federal forest management programs develop.

Cooperative Tree Planting

Several federal programs provide assistance to state forestry departments and private landowners for tree planting. The major program

utilized in the basin is cooperative distribution of planting stock under provisions of Section IV of the Clarke-McNary Act of 1924. Under this program private landowners may obtain tree seedlings from their State Forest Service for windbreaks, shelterbelts, and forest plantations.

Cooperative Watershed Program

The Watershed Protection and Flood Prevention Act of 1954 (Public Law 566, 83rd Congress) authorizes the Secretary of Agriculture to cooperate with the states, local governments, and other federal agencies to solve water management problems, plan and implement works of improvement and other purposes. There are several potential watersheds which might be authorized under this program; however, there are no existing cooperative watershed programs currently active in the basin.

Cooperative Pest Control

Authority to enter into cooperative agreement with the states is provided by the Federal Pest Control Act of 1947. The State Forester is responsible for developing insect and disease control projects on private and state land.

Recreation Resources

The Land and Water Conservation Fund Act (PL 88-578) of January 1, 1965, provides development of outdoor recreation resources by: (1) providing funds for federal assistance to the states in planning, acquisition, and development of needed land and water areas and facilities, and (2) providing funds for federal acquisition and development of certain land.

The Food and Agriculture Act of 1962 authorizes a program to assist farmers in shifting their land to nonagricultural uses. The purpose is to promote and help in the development of soil, water, forest, wildlife, and recreational resources and to establish and protect open spaces and natural beauty.

Four Corners Regional Commission

The Four Corners Regional Commission (FCRC) is one of the organized Economic Development Districts created by the Economic Development Administration (EDA). EDA is an agency within the Department of Commerce,

established by the Public Works and Economic Development Act (PL 89-136) of 1965 and amended by PL 90-103, 1967. The Four Corners Regional Commission's primary goal is to draw up plans and formulate programs to help stimulate the economic development of a 92-county area including parts of Arizona, Colorado, New Mexico, and Utah. The Commission is presently: (1) evaluating the available resources of the area, (2) establishing development goals, and (3) preparing a program that will coordinate all public and private efforts for the best socioeconomic development and growth in the region. Proposals and project suggestions will be evaluated by the commission and those with the most direct impact will be selected for initial action.

The Dolores River Basin is entirely within the Four-Corners Development Region. Coordination between the FCRC and USDA should be maintained through the USDA Rural Development Committees, SCS district leaders, and local leaders so that the greatest benefits can be realized from the available programs.

Bureau of Land Management

The Bureau of Land Management (BLM) administers approximately 1,082,600 acres within the basin, 902,000 acres in Colorado and 180,600 acres in Utah. This adds to 36% of the basin.

The Bureau of Land Management, an agency of the U. S. Department of Interior, is entrusted with the stewardship of the Public Lands. It is committed to the principle that these lands shall be devoted to the best combination of uses in the service of the Nation and for the people, now and in the future. It administers these lands for recreation, wildlife, minerals, wood, water and forage, for open space and community growth; for educational and industrial expansion; and for the security of the Nation.

The Bureau is carrying out a coordinated program for the conservation and development of watersheds in order to preserve and protect the soil and water resources. The program is a combination of land treatment and structural practices having a planned pattern in support of multiple use management. It is designed to regulate surface water runoff to control accelerated erosion, and to stabilize the soil resources. Fire protection and trespass control programs are another part of this overall resource protection program.

Through the granting of grazing licenses, permits, and leases, the Bureau administers grazing activity to protect the productivity of

the lands and to permit the highest use of forage, and carries out programs for the rehabilitation of deteriorated rangelands. The Bureau is carrying out sustained yield forest management on timberlands under its jurisdiction to obtain continuous production at the highest possible level.

The Bureau administers a program of development, conservation, and use of mineral resources through mineral leasing on Federally-owned public lands and on lands in other ownership on which the mineral rights are Federally owned. This program applies to those minerals which are not open to patent under the mining laws.

The Bureau has varied program responsibilities for management and development of outdoor recreation and wildlife values of the public domain lands which inherently involve water protection and development. These include the construction, operation, and maintenance of recreational facilities, participation with Federal, state and local agencies in cooperative programs involving the management of recreation and wildlife resources, and development of habitat for fish and wildlife."

BLM has an active range improvement program in the basin that includes brush control, fencing, reseeding, water spreading, runoff detention dams and stock watering facilities. These activities are instrumental in restoring the productivity of land damaged by fire, overuse and erosion.

BLM timber sales have been relatively small. Quality is being maintained through forest management plans that include stand improvement, insect suppression and disease control.

BLM manages sitnificant recreation resources within the basin including much of the middle Dolores River, archaeological sites and primitive lands. These resources are expected to support a geometrically rising recreation demand in the future.

The Colorado portion of Public Domain within the basin is managed by two BLM district offices headquartered in Grand Junction and Montrose respectively. The Utah portion is managed also by two BLM district offices located at Moab and Monticello.

Bureau of Reclamation

The U. S. Bureau of Reclamation (USBR) has been very active in the basin and is presently evaluating two potential projects under authority granted by the Reclamation Project Act PL 485 of August 4, 1939 (53 Stat.

1187), (Project Location Map following pg. IX-5). The San Miguel and the Dolores Projects, proposed as participating projects of the Colorado River Storage Project Act of April 11, 1956 (70 Stat. 105), both have engineering feasibility and are considered economically justified. Both projects were recently authorized in a compromise bill that included the Central Arizona Project and three additional water development projects in Colorado.

The San Miguel Project would provide all its benefits directly to the basin while the Dolores Project would primarily establish out-of-basin benefits through water exported to the San Juan River Basin. Both projects are multipurpose developments and would include direct benefits such as irrigation water, municipal and industrial water, flood control, fish and wildlife enhancement, and recreation areas. No direct power generation is planned at either project, but some Sam Miguel Project water may be used for makeup water at existing and proposed coal-fired electric generating plants in the San Miguel River Subbasin.

Late season irrigation water shortage is one of the most limiting factors in the basin's agricultural economy. New agricultural developments through project action will create additional settlement opportunities, more on-farm work, and an increase in related-service employment.

Installation of the San Miguel Project will provide a dependable water supply for agricultural, municipal, and industrial interests. Main features of the project are: (1) Saltado Dam and Reservoir, (2) Naturita Dam and Reservoir, (3) Stone Cabin and Radium Dams forming Radium Reservoir, and (4) related canals and distribution systems.

Saltado Dam, the main feature of the project, will be built on the San Miguel River about four miles downstream from Placerville. The reservoir created will store and regulate surplus flows of the river for distribution to four areas in the basin. The Norwood Canal, terminating at Naturita Reservoir, will distribute irrigation water to both new and presently irrigated land in the Norwood-Redvale area. The Mailbox Park Canal lateral will carry water to new areas along the east side of Maverick Creek, northwesterly to about six miles from Nucla. Naturita Reservoir, located on Mud Springs Draw about six miles west of Norwood, will regulate deliveries from the Norwood Canal for release through the Basin Canal. Water from the Basin Canal will be used to irrigate new and presently irrigated land in the Lilylands and Dry Creek Basin areas. The Basin Canal continues in a general southwesterly direction to its terminus on a tributary to Dry Creek Basin where the Radium Reservoir will be constructed. Radium Reservoir will provide storage facilities for water release to new land along both sides of East Paradox Creek.

The Paradox Canal will service areas on the southerly side of East Paradox Creek and will end near the Dolores River about five miles east of Paradox. The Long Park Lateral will service the northerly side of East Paradox Creek.

The Dolores Project features include McPhee Dam and Reservoir, Great Cut Dam, and related terminal reservoirs and canal systems. McPhee Dam will be located on the Dolores River about ten miles downstream from Dolores. The Great Cut Dam is a containment dike and helps form McPhee Reservoir. Water will be exported from the basin to the San Juan River Basin through two new canals, the Dove Creek and Great Cut. Primary basin benefits resulting from the project are flood control, recreation, water quality improvement and wildlife enhancement. Benefits outside the Dolores Basin will be described in the San Juan River Basin Report.

USBR has a tentative salinity control project on the Dolores River in the Paradox Valley area. A regulating reservoir, bypass canal, diversion canal, and evaporation reservoir are increments of the project. Present standards for making benefit to cost comparisons indicate this project has low feasibility. It also is located in an area where the Colorado Divison of Game, Fish and Parks is proposing a reservoir.

USBR also can provide project assistance through the Small Projects Act, PL 984. A possible application of this act is enlargement of Gurley Reservoir now under consideration. The reservoir level will be raised a minimum of six feet with a corresponding increase in storage capacity of over 2,000 acre-feet. Increased capacity will allow for improved efficiencies in irrigation water by retaining water, normally used in the spring, for later periods of more acute need.

Bureau of Sports Fisheries and Wildlife

The U. S. Bureau of Sport Fisheries and Wildlife does not have any existing developments in the basin. There is a recognized need, however, for a waterfowl refuge or management area; and long range plans consider development to meet this need in cooperation with the Colorado Division of Game, Fish and Parks.

Two possibilities for development now being studied are supplemental features of the U. S. Bureau of Reclamation's proposed San Miguel and Dolores Projects. The Dolores Project would provide water for an out-of-basin waterfowl area to be located in the San Juan River Basin. (Benefits and project details will be discussed in that river basin report.) The San Miguel Project would provide a unique opportunity for

fish and wildlife development at the Radium Reservoir. Independent control of the two sides of the reservoir would be a valuable feature of the projected Radium Fish and Wildlife Area. The Bureau of Sport Fisheries and Wildlife would aid in the cooperative development of management plans for this facility. The bureau would also assist in annual stream improvement work to be performed on the San Miguel River as part of a specific fish and wildlife program for authorized elements of the Colorado River Storage Project.

The bureau is also cooperating with state agencies on potential recreation developments on private projects such as the proposed Gurley Reservoir enlargement.

U.S. Army Corps of Engineers

Since flood damages are minor there has not been any need for large scale flood control projects. Two areas in the basin have received some benefits through U. S. Army Corps of Engineers action. Temporary protection for Dolores was provided by channel rectification and levee repair along the Dolores River. Also, some channel rectification and clearing along Silver Creek was done for the temporary protection of Rico. Both projects were completed between 1949 and 1952 and have functioned satisfactorily. The corps recently improved the channel protection work at Dolores to provide additional protection during peak snowmelt runoff periods. The Corps spent $25,000 in 1970 for control and works of improvement under emergency planning funds to protect the town of Telluride.

Colorado Division of Wildlife [2/]

The division has been active throughout the basin in both fish and game management activities. There is a continuing program of fish management on virtually all suitable water areas in the basin on public land. Some water is stocked every year and other may be stocked only once in five years. Over 20,000 pounds of rainbow trout are stocked in reservoirs and lakes each year in the basin and over 28,000 pounds are placed in rivers and streams. Fingerling stocking in 1968 totaled over 700,000 including rainbow, brook, and native trout.

The fish rearing unit at Dolores produces about 30,000 pounds of catchable size rainbow trout annually, most being placed in basin streams. The unit has 5 one-acre ponds and 9,000 square feet of raceways. The Dolores River provides a plentiful supply of water for raising fish but if a warmer source of winter water could be developed, production would be

---

2/ Formerly part of the Colorado Division of Game, Fish and Parks.

tripled. Ground water explorations have not proven successful. The division has one designated recreation area that has sanitation and picnic facilities only. In this area Joe Moore Reservoir is part of a complex including Summit and Puett Reservoirs located near the boundary separating the Dolores and San Juan Basins. In addition, the Division provided money for an access road to Groundhog Reservoir for public fishing. Miramonte Reservoir, completed in 1967, will be an improved recreation area when facilities are available in 1969-70.

Game management projects have included numerous chukar partridge releases during the early 1960's and antelope transplants (46 animals) in Disappointment Valley between 1962 and 1964. Several range rehabilitation projects have been carried on, the latest being a cooperative effort with the Forest Service on Ryman Creek. The division also has purchased land along Fish Creek to manage as big game winter range. These cooperative projects between federal land use agencies and the division will continue and are designed to increase winter range carrying capacity for big game.

VIII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Availability of Land for Potential Development

Development of new irrigated land in the basin will require additional development of water supplies. The proposed San Miguel Project will supply water for approximately 26,000 acres of new irrigated land. The land to be irrigated has a combination of favorable climate and moderately deep and deep loamy soils for production of pasture, alfalfa, small grains and corn silage. The favorable land is mainly in soil mapping units 2 and 4 on the General Soil Map. Slopes are nearly level to rolling. Ownership of the land is both private and public. There has been an expressed willingness of owners having excess land to dispose of the land for project development. Land under public ownership would be available for development.

Other small scattered land areas within soil mapping units 1, 2, and 4 are suitable for irrigation. However, water supply development is limited and none are proposed. This land includes loamy textured soils derived from sandstone, fine textured soils derived from shale, and loamy soils on slopes of less than nine percent. Many of the soils in unit 4 are on high mesa tops making it too costly to supply these areas with water.

Suitable land areas for recreational sites are abundant in soil units 4, 5, 6, and 7. Soil unit 3 is dominantly steep and rocky, but the river bottom areas in this unit provide some of the best recreational sites. Soil unit 1 and 2 are less scenic and limited in available water necessary for recreation development. Soil unit 8 is above timberline.

Impoundments

Many potential impoundments have been proposed to help meet the needs for additional storage facilities. Federal, state, and private interests have made studies and investigations concerning water and related land resource developments. Many of these water development proposals warrant further detailed analysis and may eventually become part of the basin's developed resources. Other proposals may never mature because of changing demands in water requirements and current developments. All known water development proposals involving a sizeable impoundment have been considered. Those that have good development potential are listed in Table 59. Potential impoundment locations are shown on the Project Location Map following page IX-5. The 15 potential reservoirs or enlargements listed would provide 535,400 acre-feet of additional storage capacity.

Table 59.--Potential impoundments, Dolores River Basin in Colorado and Utah

Reservoir name	Location 1/	Principal use 2/	Estimated capacity acre-feet
Bear Creek	2-b	Irrigation	8,000
Beaver Creek	2-a	Irrigation	8,000
Buckeye (enlargement)	1-a	Irrigation	4,200 3/
Calamity Draw	4-a	Recreation	1,300
Disappointment Valley	10-c	Recreation	4,200
Gurley (enlargement)	9	Irrigation	13,600 3/
Gypsum Valley	10-b	Recreation	7,500
Lilylands (enlargement)	11	Irrigation	1,000 3/
McPhee	7-a	Irrigation	364,000
Monument	4-b	Recreation	1,000
Naturita	8-b	Irrigation	9,200
Paradox Valley	10-a	Recreation	15,000
Radium	10-d	Irrigation	25,600
Saltado	8-a	Irrigation	72,600
Spradlin Park	4-c	Recreation	200

1/ Project Location Map (page IX-5)

2/ Principle use of stored water or water to be released from storage. There are opportunities for recreation development in or near all of the potential impoundments. Multipurpose reservoirs will include storage for municipal and industrial use, flood control, and sediment.

3/ Total capacity with enlargement.

Source: Developed from federal, state, and private potential project reports.

Water Developments

Rural Domestic and Livestock Water Supply

Water for rural domestic use is diverted or hauled from surface water sources or is pumped from wells. Cisterns also are used to store water that is collected as precipitation or delivered by pipe or other methods. There is an adequate supply of ground and surface water available to meet present and future potential demands. New rural residents, attracted by agricultural water developments, will have to provide domestic water facilities on an individual need basis. Unconsolidated alluvium along main drainages can be tapped by wells that should produce 25-500 gallons-per-minute at relatively shallow depths (less than 300 feet).

Livestock water, primarily obtained from surface water sources, will have to be developed to meet expected increases in livestock numbers. There is an abundant supply of sites for stock pond development and sufficient amounts of water to adequately supply future demands. In cases where augmentation from ground water sources is needed to maintain water levels of stock tanks, wells can be developed where resources permit.

Municipal and Industrial Water and Related Developments

There are adequate amounts of surface water supplies available for potential municipal and industrial developments. Many of the larger communities in the basin have piped water distribution systems, which are municipally owned, and deliver water developed from surface water sources. Norwood, Rico, and Telluride, because of distribution system limitations, have a potential for expansion or improvement of their facilities. Naturita has a need for both sewer and water facility improvement. Other communities now using ground water supplies may have to develop new sources and facilities to meet expected increases in use and per capita consumption.

Industrial water can be readily obtained by development of the available resources along the San Miguel and Dolores Rivers. Extensive deposits of bituminous coal are located at shallow depths in the Nucla area. Development of this resource will include expansion of existing and construction of new coal-fired electric generation plants. Demand for plant makeup and cooling water is estimated at 18,000 acre-feet per year by 2020. Available resources will adequately supply this requirement.

Potential development of potash deposits in Gypsum Valley would require large amounts of water during mining and processing operations. Active exploration of the potash resource is under way, and a water use of 5,000 acre-feet is estimated by 2020. This requirement could be obtained from either the Dolores or San Miguel River.

The basin also has many factors such as space, topographic features, water, and scenic beauty that are considered prime characteristics of recreation development. Many agencies and individual developers are realizing the potential of the basin to satisfy pressing national needs for outdoor recreation. Exploitation of this potential will increase.

Channel Improvements and Levees

The town of Dolores, because of urban encroachment along the floodway of the Dolores River, has been given protection by construction of two miles of levee under emergency planning funds. There is a potential for channel improvements on two small drainages which run through the town and empty into the river.

Levee on San Miguel River near Placerville

Temporary levee and channel improvements were made at Rico in the 1940's, but a new highway and other developments pose greater potential loss in the event of flood. Maintenance and improvement of the channelization work on the Main Stem of the Dolores River would provide greater flood hazard protection for new developments.

Most of the agricultural land in the basin is above the flood areas along major streams. Some irrigated land, above and below Dolores along the Dolores River, could be protected by channel revetment or streambank

stabilization to reduce streambank erosion during the peak runoff periods. All channel improvements should provide for the protection of fish habitat.

Farm Drainage

Farm drainage as a practice has had but limited acceptance to date. The irrigation farmers of the area have been slow in accepting the "salinity hazard" principles as stated under Water Quality Limitations, Chapter V, and Drainage Improvement, Chapter VI, as being the basis for drainage needs. The leaching requirement, plus the requirement that ground water should not be allowed to more or less permanently build up in the crop root zones, should determine the intensity of drainage.

There should be a gradual expansion of drainage using the above criteria as a guide until the practice is accepted. Eventually it can be expected that about one-third of the irrigated acreage will have drains installed. Presently the yields on these acreages, one-third of the total irrigated, are estimated to average only 50 percent of that from comparable land which does not have salinity or drainage problems. In other words, one-third of the presently irrigated acreage produces one-fifth of the total production. With good drainage practices a composite acre in the basin should have an increased production of twenty percent.

Individual systems and small group action projects, where conditions such as access and property lines are factors, are generally satisfactory.

Irrigation Systems

Irrigation systems throughout the basin vary from well developed -- relatively efficient operations, to poorly developed -- inadequate and inefficient systems. There is improvement potential to be found in most all existing systems. More effective diversion, control, and delivery of water can be attained by reorganization and consolidation of existing facilities and implementation of better water management practices along with new facilities. Increased effectiveness in the use of available water resources can help establish a more productive agricultural economy as well as conserving the resource.

Water supply projects proposed by governmental and private concerns will stimulate the development of new irrigation systems. The availability of additional water supplies will create development opportunities for new head ditches, laterals, turnouts, control structures, land leveling or other field preparations, and perhaps water recovery facilities.

Outdoor Recreation - Proposed and Potential Areas

The U. S. Forest Service, Bureau of Land Management, and Colorado Division of Game, Fish and Parks are planning future recreation facility development in the Dolores River Basin. Likewise, the private sector is anticipating future water development for water-dependent recreation activities. However, knowing or trying to find out what, when, and how much recreation facility the private sector in toto will provide or plan for is extremely difficult to estimate. Nevertheless, Table 60 gives a picture of known, proposed facility development for federal and state agencies and private ownerships. As far as public agencies are concerned, construction is contingent upon available funds. And, of course, the likelihood of private recreation development hinges upon a favorable, business activity in our national and regional economies.

Table 60.--Future public and private outdoor recreation development for selected activities, Dolores River Basin in Colorado and Utah, 1980 and 2000

Sector	Activities			
	Cold water fishing	Boating	Camping	Picnicking
	Surface acres	Surface acres	Sites	Sites
Public				
1980	3,000	2,765	800	200
2000	1/	1/	1,350	350
Private				
1980	70	65	n.p. 2/	n.p.
2000	n.p.	n.p.	n.p.	n.p.
Total				
1980	3,070	2,830	800	200
2000	-	-	1,350	350

1/ Exact surface area unknown for Radium Reservoir, San Miguel Project.

2/ n.p. = no plans currently known.

Source: Developed by USDA Field Party from information obtained through federal and state agencies.

The Colorado Division of Game, Fish and Parks is working on plans in conjunction with the projected development of Gurley Reservoir for use as an improved recreation site. Enlargement planning, with a potential projection date of 1980, includes plans for additional water storage (1,500 acre-feet) for fishing and recreation purposes. Combined with the enlargement is the possible development of campground facilities to provide an attractive recreational use area of important economic impact to the basin.

The division is also involved in cooperative planning with the U. S. Bureau of Reclamation for a wildlife enhancement area to be known as the Radium Fish and Wildlife Area. In addition to the reservoir area, it is planned that about 1,900 acres would be acquired and administered by the division to help ameliorate the expected damages to wildlife habitat resulting from U. S. Bureau of Reclamation projects.

Three other developments are under consideration by the division. These include sites for three large reservoirs on the lower Dolores River in: (1) Paradox Valley, (2) Gypsum Valley, and (3) downstream of the confluence of Disappointment Creek. These projects are large and costly and still in the planning stage, but if completed they would create nearly 40 miles of fishing stream where none presently exists and three lakes covering 3,200 surface acres.

Recreation development is presently underway at Miramonte Reservoir and at Woods Lake with facilities scheduled to be completed in the early 1970's. These two San Miguel County developments will also be maintained and managed by the Colorado Division of Game, Fish and Parks.

Buckeye Reservoir, a part of the PL 566 West Paradox Watershed, also has plans for additional water storage for recreation and has a potential projection date of 1980.

From USDA watershed investigative studies, three small potential impoundments (Calamity Draw, Monument, and Spradlin Park) would provide cold water fishing opportunities (see Table 60). In addition to these there are three potential sites on Maverick Creek. There are several opportunities for small fishing impoundments in the Uncompahgre National Forest on Clay, McKenzie, and Tabeguache Creeks.

Recreation development will be included in the Bureau of Reclamation's San Miguel Project and Dolores Project (in particular Radium Reservoir in the former project and McPhee Reservoir in the latter offer recreation development provisions). Although Congress has authorized construction of these projects, it has not appropriated construction funds.

Preliminary plans have been announced for construction of a $10 million ski resort complex. This "Vail-type" development will be located on 4,300 acres at the western edge of Telluride town limits. A California developer is expecting to open the resort in the fall of 1973.

The Dolores County Board of County Commissioners has acquired 40 acres of land from the Bureau of Land Management along the Dolores River about 4½ miles northeast of Dove Creek. Development of the area includes picnic sites and a camping area. Addition of a camping area is proposed for later development.

Town officials, businessmen, and a local ladies social group have proposed plans for constructing an indoor-outdoor swimming pool at Norwood. The pool would be located on the town's public school grounds. A steering committee has been selected that will establish and implement a program to acquire the funds (approximately $100,000) for the much-needed facility.

Forest Lands

In the early 1960's the Forest Service cooperating with the Outdoor Recreation Resources Review Commission (ORRRC) completed a national survey of its recreation potential. In the basin there is sufficient area suitable for development to satisfy projected demands through the year 2020. On national forest land it appears that most of the highest quality sites will be developed by the year 2000.

Potential development includes improvement and expansion of existing sites, a five-fold increase in the number of camping and picnicking sites, boat launching sites and marinas, several hundred miles of scenic roads, several hundred miles of recreation trails, and several thousand acres suited for expansion or creation of winter sports areas.

Water Quality Control

Recent enactment of state water pollution control standards should result in the elimination at the source of much of the mining, industrial, and municipal water contaminates. Downstream suspended sediment loads will be lessened due to the detention of upstream sediments in the reservoirs projected to be built. Biochemical Oxygen Demand (BOD) as an indicator of pollution related to large scale animal feeding operations, dairies, or sugar beet processing is not projected as a possibility. None of these enterprises are expected in the basin.

A slight degradation in water quality is expected because of the increase in dissolved solids from additional irrigated land. The dilution effect of river flow will be decreased when water from the upper reaches of the Dolores River is diverted for use in the San Juan Basin. The Water Quality Control section, Chapter VI, has estimates on this in terms of dissolved solid increases.

The Federal Water Quality Administration[1/] and the Bureau of Reclamation have made studies of a very preliminary nature for control of the salinity pickup which occurs in the Paradox Valley. Benefits from this control would be largely to the Colorado River since this salt pickup occurs below the major irrigated areas of the Dolores River Basin. Present considerations include four features for this control: (1) a dam immediately upstream from Paradox Valley to control river flows and permit them to be released at regulated rates, (2) a dam immediately below Paradox Valley that would serve as an evaporating pond for inflows to the Dolores River below the upper dam, (3) a concrete lined canal to convey releases from the upper dam around the east side of the evaporation reservoir and back to the Dolores River below the lower dam, and (4) an unlined canal to divert the uncontaminated flows of West Paradox Creek, which normally enter the Dolores River in Paradox Valley, around the west side of the evaporation reservoir and then back to the Dolores River. The investment cost of such a project has been estimated to be in the order of $17 million with the benefits related to costs as slightly less than 1:1.

Land Treatment and Adjustments

Regardless of ownership, state, federal, or private, there is a potential of improving management practices and applying conservation measures on land not yet adequately treated and on land that will be changed to new uses.

Potential treatment and adjustments include: (1) improving cover on crop, forest, pasture, range, and wildlife lands, (2) retaining water for beneficial use, (3) protecting land against soil erosion, (4) reducing water and sediment damage, and (5) improvement of systems and water management on irrigated land.

1/ Now part of the Environmental Protection Agency.

Western wheatgrass on former dry cropland

Forest Land

Timber

The projected demand for timber products can be met if utilization of available wood is improved and management to achieve the full potential of growth is implemented. The supply of timber could be roughly doubled by eliminating current losses due to insects, diseases, fire, and other mortality. Timber from land clearing, thinnings, other cultural operations, and land conversion to other uses could be utilized more efficiently. Finally, it is estimated that intensified forest management could improve the net growth rate from 23 to about 93 cubic feet per acre. The prospective and potential timber supplies are compared in Table 61.

Table 61.--Projected supply of growing stock with prospective (current) and potential levels of utilization and management, 1980, 2000, and 2020, Dolores River Basin.

Year	Prospective Supply		Potential Supply	
	Total volume (million cu. ft.)	Volume per acre (cubic feet)	Total volume (million cu. ft.)	Volume per acre (cubic feet)
1980	37	49	41	50
2000	40	54	53	72
2020	40	54	69	93

Grazing

Although no specific need or unfulfilled demand for grazing has been identified, there is a trend to expanded livestock production. In the future there will be increased pressure on forest range as ranching operations expand. The capacity for grazing can be increased by 25 to 50 percent if developments such as water facilities, fencing, and revegetation are implemented along with more intensive management and control.

Wildlife and Fisheries

The additional needs for hunting can be provided by management of forest habitat. The physical potential for water facilities and enhancement measures is sufficient to accommodate the needed developments.

Most of the additional cold-water fishing needs will be satisfied by lakes and reservoirs. Stream fisheries can be improved, restored, or enhanced to supplement flat-water fisheries and provide variety. The physical potential for development of lakes, reservoirs, and streams appears to be sufficient to satisfy projected demands.

Water Management and Water Quality

The needs for water management will be provided mainly through structural development. There is a potential for increasing water yield and prolonging water release through snowpack management in forest areas. Research in this field is currently being conducted by the Forest Service (Rocky Mountain Forest and Range Experimentation Station),

and results have been promising. However, there has not been enough application to support extension of research findings from experimental areas to general forest areas. Because of this limitation specific estimates of water yield increases cannot be made.

The primary water pollutant on forest land is sediment. There is a large potential for land treatment to reduce sediment production, especially the accelerated production which results from human use of the forest.

IX. OPPORTUNITIES FOR DEVELOPMENT AND IMPACT OF PROGRAMS

The purpose of the Department of Agriculture's participation in the basin survey is to contribute to a future comprehensive plan for the coordinated and orderly development, management, and use of the water and related land resources of the Dolores River Basin. Such a plan would point out the measures necessary to attain the highest level of long-term benefits to the people of the basin, adjacent communities, and to the nation.

Significant opportunity exists in the basin for the initiation of new activities, and the strengthening of existing programs and operations which involve water and related land resources. These USDA opportunities can be classed as those relating primarily to group project poossibilities, with restricted or defined funding, while the other relates to the regular operations of the Department's resource agencies in carrying out their own designated responsibilities.

USDA Development

Potential PL 566 Projects

Field investigations indicate that four watersheds in the Dolores River Basin have potential for development by 1980 under the amended authority of PL 566 (Project Location Map, following page IX-5). Three of these projects are agricultural water management and irrigation system rehabilitation potentials and include potential recreation developments. The other watershed is a flood prevention project.

The total cost of the structural measures for the four early-action watershed projects is estimated at $2,020,500, of which about $884,500 would be provided by non-federal project sponsors. Annual operation and maintenance costs, all non-federal, would be about $14,600.

The structural measures consist of three reservoirs with a combined storage capacity of 4,297 acre feet. Rehabilitation of irrigation distribution systems consists of 11 drop structures, 66 turnouts, 181 measuring devices, 36 wasteways, 10 miles return flow ditches, 6 miles canal enlargement, 7 miles canal lining, five syphons, 10 flumes, 3 miles canal realignment, 3¼ miles of drains, 3 miles lateral combination and 2,800 feet of intake canal stabilization. In addition, 2,400 feet of floodway channel, two debris basins and three grade stabilization structures are proposed.

The following is a summary of these four potential projects.

Dolored Watershed

The Dolores Watershed contains an area of approximately 775 acres, of which all is in private ownership, and is located in northcentral Montezuma County, Colorado. The watershed consists of two small drainages which originate about two miles northeast of Dolores. These streams generally flow in a southerly direction until they join and flow through the town of Dolores and into the Dolores River. The topography abruptly changes near Dolores as the streams drop down into Dolores and the valley floor of the Dolores River.

Approximately 643 acres of the watershed is in rangeland, and of this, 25 percent has a pinyon-juniper cover. Twelve acres are in cropland and the remaining 120 acres are in urban use.

Flooding from the two small streams above the town is the major problem in the watershed. The flood that occurs on the average of once in 100 years would inundate approximately 120 acres, all of which are in Dolores. This flood would result in damages to 94 houses, businesses, churches, and schools. Also, considerable cost is included in removing sediment and debris after flooding has occurred.

The proposed structural measures to protect the town of Dolores from flooding consists of two floodwater retarding structures, two floodway channels, two debris basins, and three grade stabilization structures.

The estimated total installation cost is $201,900.

Gurley Watershed

The Gurley Watershed contains about 244,300 acres, of which 53 percent are in private ownership and 47 percent federal, and is located in parts of Montrose, San Miguel and Dolores Counties, Colorado. Elevations vary from over 13,200 feet in the San Miguel Mountain headwaters to 5,400 feet near Naturita.

There are approximately 110 farms in the watershed with about 14,400 acres of irrigated land. The Farmers Water Development Company serves about 6,000 acres (70 water users) and the Cone Reservoir and Ditch Company serves about 3,000 acres (27 water users.) The remaining irrigated land, 5,400 acres, obtains its water from other various sources.

Of the lands served by the two irrigation companies, approximately 7,500 acres are used to produce hay or pasture and the remaining 1,500 acres are in small grain, primarily malting barley. Malting barley has become a crop that helps diversify present livestock oriented farming operations.

The main agricultural problems are inadequate irrigation water supplies during the latter part of the growing season and poor water management practices resulting from outdated water handling systems. Forty to sixty percent of the lands served by the two irrigation companies are presently short of water after the end of July.

The proposed structural measures for irrigation system rehabilitation to meet the early-action needs consist of the replacement, installation or improvement of the following: (1) 9 drop structures; (2) 27 turnouts and measuring devices; (3) 10 miles of canal improvements; (4) 2 diversion structures; (5) 12 miles of drains and return flow ditches; (6) 1 wasteway; (7) erosion protection and stabilization of the Beaver Intake Canal; (8) 2 diversion structures; and (9) 3 miles of lateral combining. (These measures will complement the U.S. Bureau of Reclamation's potential Gurley Reservoir enlargement and the San Miguel Project.)

The estimated total installation cost is $947,300.

Gurley Reservoir

Tabeguache Watershed

The Tabeguache Watershed contains about 194,180 acres, of which approximately 15 percent is in private ownership and 85 percent is federal, and is located in Montrose and Mesa Counties, Colorado. Elevations above sea level vary from about 10,000 feet on the Uncompahgre Plateau to about 5,000 feet near Uravan.

Agriculture (primarily oriented toward the production of livestock), mining (uranium-vanadium and coal), and electric power generation are the primary industries in the watershed.

There are an estimated 140 farms in the watershed and 5,900 acres of irrigated land. Of the irrigated lands, 4,860 acres are served by the Colorado Cooperative Ditch Company (CCDC). Present cropping patterns are 39 percent alfalfa, 39 percent grass hay or pasture, 14 percent corn, and 8 percent small grains.

The primary need in the watershed is the rehabilitation of the present irrigation system served by the CCDC. New turnouts and measuring devices are needed to aid the irrigators in managing their water applications. Canal lining is also needed to reduce seepage losses in many laterals.

The proposed structural measures for irrigation system rehabilitation to meet the early-action needs consist of the replacement, installation, or improvement of the following: (1) 2 drop structures; (2) 6 miles of canal improvements; (3) 220 turnouts and measuring devices; (4) 35 wasteways; (5) 15 flumes and syphons, and (6) 1¼ miles of outlet drains.

The estimated installation cost is $545,600

West Paradox Watershed

The West Paradox Watershed contains about 60,300 acres, of which approximately 50 percent is in private ownership and 50 percent is federal, and is located in portions of Montrose County, Colorado and San Juan and Grand Counties, Utah. Elevation above sea level varies from about 5,000 feet to over 12,600 feet. Most of the agricultural lands range from 5,000 to 5,500 feet in elevation.

The principal economic activity in the watershed is the small family operated irrigation and livestock enterprise. Much of the irrigated land is used for the production of livestock feed. Livestock and livestock production account for the major source of income, however, some malting barley is grown as a cash crop.

Several small uranium mines are located in the lower half of the watershed. Their economic significance is minor. Also of minor significance are some limited timber operations. A small sawmill in Paradox produces lumber, cants and railroad ties from Ponderosa pine.

The primary problem is a lack of a stable irrigation water supply. The total area irrigated in an average year is about 2,500 acres. This will vary from 2,000 to 3,500 acres depending on the years water supply. The need is for additional water storage capacity along with improved irrigation water management practices.

The most economically feasible solution appears to be enlargement of the existing Buckeye Reservoir from its present capacity of 1,600 acre-feet to 4,217 acre-feet. This would provide 3,400 acre-feet for irrigation and a conservation pool of 817 for sediment storage and recreation.

The conservation pool would have an estimated surface area of 69 acres and could provide approximately 5,000 visitor days of recreation use.

The estimated total installation cost is $325,700.

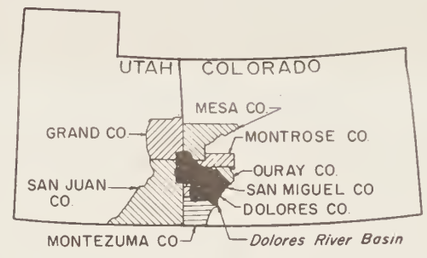
PROJECT LOCATION MAP

DOLORES RIVER BASIN

COLORADO and UTAH

JULY 1968

SCALE IN MILES



LOCATION MAP

KEY TO WATER DEVELOPMENT PROJECTS

USDA PROJECT OPPORTUNITIES

1 West Paradox - PL 566 AWM project potential
- 1a Buckeye Reservoir

2 Montezuma Valley Irrigation Company - PL 566 AWM project potential, alternate to No. 7
- 2a Beaver Creek Reservoir Site
- 2b Bear Creek Reservoir Site

3 Curley - PL 566 AWM potential

4 Tabeguache - PL 566 AWM potential
- 4a Calamity Draw Reservoir Site
- 4b Monument Reservoir Site
- 4c Spradlin Park Reservoir Site

5 Naturita - FHA application, sewer and municipal water systems improvement

6 Stoner - FHA application, recreation facility improvement

19 Dolores - RC&D Flood prevention potential

USBR PROJECT OPPORTUNITIES

7 Dolores Project - Authorized multipurpose water development
- 7a McPhee Reservoir Site
- 7b Great Cut Dam Site and export canals

8 San Miguel Project - Authorized multipurpose water development
- 8a Saltado Reservoir Site and canal
- 8b Naturita Reservoir Site and canals
- 8c Radium Reservoir Site (single reservoir created by Stone Cabin and Radium Dams)
- 8d Paradox diversion and canals

9 Curley Reservoir enlargement - Farmers Water Development Company (PL 984 Small Projects application)

STATE PROJECT OPPORTUNITIES

10 Colorado Department of Came, Fish and Parks
- 10a Paradox Valley Reservoir Site - Recreation development
- 10b Cypsum Valley Reservoir Site - Recreation development
- 10c Disappointment Valley Reservoir Site - Recreation development
- 10d Radium Reservoir Site - Waterfowl management area, addition to 8c
- 10e Curley Reservoir enlargement - Recreation development, addition to 9

PRIVATE PROJECT OPPORTUNITIES

11 Lilylands Reservoir enlargement - Lilylanda Canal and Reservoir Company

OPERATING PROJECTS

12 Dolores River at Dolores - U. S. Army Crops of Engineers, Channel rectification

13 Silver Creek at Rico - U. S. Army Corps of Engineers, Channel rectification

14 Miramonte Reservoir - Colorado Department of Came, Fish and Parks, Recreation development

15 Leopard Creek Diversion - Out-of-basin export

16 Summit Irrigation Company - Out-of-basin export

17 Montezuma Valley Irrigation Company - Out-of-basin export

18 La Sal Diversion - Out-of-basin export

LEGEND

- CITIES AND TOWNS
- PROPOSED RESERVOIR
- RESERVOIR
- COUNTY LINE
- STATE LINE
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- NATIONAL FOREST, PRIMITIVE AND NATURAL AREAS
- CANAL
- PROPOSED CANAL
- SIPHON
- PROPOSED SIPHON
- TUNNEL
- PROPOSED TUNNEL

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLORADO 1968

4070-5

GPO 853-472

Land Treatment Program Under PL 46 and Related Authorities

Land treatment is a continuing need. The department, through the Soil Conservation Service, Agricultural Stabilization and Conservation Service, and the Farmers Home Administration, provides technical and financial assistance to landowners and operators for the planning and application of land treatment measures. Because of shifts in land use and accompanying changes in treatment needs, the department periodically reviews and inventories the land treatment requirement on nonfederal rural lands. The most recent, the Conservation Needs Inventory, was made in 1966. Results of the inventory show that 158,400 acres (or 23 percent) of 687,300 acres of state and private agricultural lands in the Colorado portion of the basin are in need of some type of land treatment. Based on the current rate of application, it is estimated that about 101,720 acres of the treatment needs will be completed by 1980. In order to assure protection of the resource many of the measures may need to be applied at an accelerated rate. This will depend upon the location and rate of installation of potential developments.

The Conservation Needs Inventory in the Utah portion of the Dolores totals 107,090 acres. Thirty-one percent of state and private agriculture lands are in need of some type of land treatment. Based on the current rate of application, it is estimated that about 18 percent will be completed by 1980.

Conservation on agricultural lands requires a combination of improvement measures and management practices. The following measures and practices are typical of the requirements of this area:

(1) Irrigated cropland

(a) Irrigation systems improvement - This includes such measures as the reorganization of existing systems, land leveling, ditch lining, erosion control measures, and drainage.

(b) Water management - Proper irrigation water management is needed to: (1) control soil erosion, (2) prevent excess water losses, and (3) time water applications to meet crop needs. Adequate irrigation systems must be installed before proper water management can be accomplished.

(2) Dry farm cropland

(a) Residue and annual cover - Crop residue management, annual cover crops, or other annual recurring measures used locally when needed to meet the conservation problems.

(b) Stripping and diversions - This includes strip cropping and diversions that are needed to treat and protect the land. In addition, measures such as sod waterways and contour stripping may be used to supplement these practices.

(c) Permanent cover - This practice is for lands that are unsuited for row or grain crops and a land use change to a permanent cover of grass or trees is needed.

(3) Pasture and rangeland

(a) Protection only - Protection of plant cover from overgrazing. Livestock management and distribution is needed on overgrazed land to enable rangeland to recover and reseed naturally.

(b) Brush control and improvement - Chemical or mechanical measures are needed to eradicate or control the encroachment or undesirable woody, poisonous, and noxious plants that has destroyed or threatens the grass cover.

(c) Reestablishment of vegetative cover - This is a more intensive treatment. The pasture or range needs a complete reestablishment (without brush control) of vegetative cover. During the period of reestablishment these lands are protected from livestock grazing that might cause damage.

(d) Reestablishment with brush control - Brush control measures are necessary in the reestablishment of a desirable vegetative cover.

Tables 62 and 63 show the conservation treatment needs on state and private agricultural lands in the Dolores River Basin in Colorado and Utah and the amount of treatment that is expected to be completed by 1980.

National Forest Developments and Multiple Use Programs

There are many possibilities for accelerated development to meet needs and solve problems on national forest land. Since the project areas of the identified potential PL 566 watersheds do not include national forest land, this program offers little opportunity for national forest projects. However, the existing national forest programs can be accelerated or expanded to develop practically all of the potential previously identified. The measures discussed below are in addition to those scheduled under existing programs (Chapter VII).

Water resource project possibilities include: 165 miles of gully control, 12,750 acres of sheet erosion control, restoration of 250 miles of eroding abandoned roads and trails, 100 miles of streambank stabilization, restoration of mined areas on 425 acres, 70 acres of treatment for water pollution abatement, and 30 miles of alpine snowpack management (Table 64.)

Vegetative measures planned primarily to benefit other resources often have equally beneficial effects on watersheds. Opportunities for development with these effects include the range revegetation and type conversion, range fencing to protect problem areas and newly established vegetation, and reforestation and afforestation programs discussed below. Installation of these programs should control most erosion and sediment production from current sources. Continuing treatment on new problem areas and future disturbances is essential to maintain the effectiveness of all measures.

The full potential for timber production can be achieved if the following measures are included in an accelerated program: release, weeding, thinning, and pruning on 17,950 acres of timber; reforestation and afforestation of 3,100 acres of land (Table 64.) These measures added to those discussed in Chapter VII can improve the net growth rate to the potential rate of over 90 cubic feet per acre and will provide a potential timber supply of about 69 million cubic feet for the year 2020.

Table 62.--Projected changes in livestock feed or forage production by land use and treatment practices, state and private land, Dolores River Basin in Colorado, 1980

Land use and treatment	Estimated land treatment needs	Treatment completed by 1980	Treatment completed by 1980	Forage increase if needed treatment is applied	
	Acres	Percent	Acres	AUM's	Dollars 1/
Cropland practices					
Cultural or management measures	2,200	80	1,800	1,380	8,280
Improved irrigation system	5,500	80	4,400	4,840	29,040
Irrigation water management	4,200	65	2,730	3,000	18,000
Residue and annual cover	800	60	500	50	300
Strip cropping, terraces or diversion	1,800	70	1,260	130	780
Permanent cover	1,000	50	500	50	300
Subtotal	15,500		11,170	9,450	56,700
Pasture and range practices					
Needs protection only	65,700	90	60,000	6,000	36,000
Needs improvement only	19,300	78	15,000	1,500	9,000
Brush control and improvement	25,200	40	10,000	2,000	12,000
Reestablishment of vegetative cover	4,000	63	2,500	1,250	7,500
Reestablishment with brush control	900	65	590	300	1,800
Subtotal	115,100		88,090	11,050	66,300
Forest					
Establishment and reinforcement of timber stands	7,200	6	400	40	240
Timber stand improvement	20,600	10	2,060	210	1,260
Subtotal	27,800		2,460	250	1,500
Colorado Total	158,400		101,715	20,750	124,500

1/ Adjusted normalized price.

Source: Developed by USDA Field Party

Table 63.--Projected changes in livestock feed or forage production by land use and treatment practices, state and private land, Dolores River Basin in Utah, 1980

Land use and treatment	Estimated land treatment needs	Treatment completed by 1980	Treatment completed by 1980	Forage increase if needed treatment is applied	
	Acres	Percent	Acres	AUM's	Dollars 1/
Cropland practices					
Cultural or management measures	250	80	200	153	918
Improved irrigation system	1,700	80	1,360	1,496	8,976
Irrigation water management	200	65	130	143	858
Residue and annual cover	920	60	550	55	330
Strip cropping, terraces or diversion	500	70	350	36	216
Permanent cover	250	50	125	13	78
Subtotal	3,820		2,715	1,896	11,376
Pasture and range practices					
Needs protection only	14,920	90	13,430	1,343	8,058
Needs improvement only	780	78	610	61	366
Brush control and improvement	300	40	120	24	144
Reestablishment of vegetative cover	1,380	63	870	435	2,610
Reestablishment with brush control	400	65	260	132	792
Subtotal	17,780		15,290	1,995	11,970
Forest					
Establishment and reinforcement of timber stands	1,310	6	80	8	48
Timber stand improvement	10,410	10	1,040	106	636
Subtotal	11,780		1,120	114	684
Utah Total	33,380		19,125	4,005	24,030
Total - Colorado and Utah	191,780		120,845	24,755	148,530

1/ Adjusted normalized price.

Source: Developed by USDA Field Party

Table 64.--Comparison of land treatment and structural measures currently planned and opportunities for accelerated development, Grand Mesa-Uncompahgre, Manti-La Sal and San Juan National Forests, Dolores River Basin, Colorado and Utah.

Item	Unit	Amount Currently Planned (Table 58-Chap. VII)	Opportunity for Accelerated Development
Range revegation - plant control and type conversion	acres	55,400	39,910
Range management - stock distribution trails	miles	65	45
Range management - fences	miles	160	200
Range management - water development	each	270	215
Reforestation and afforestation - planting and seeding	acres	22,700	3,100
Timber management - release, weeding, thinning and pruning	acres	39,050	17,950
Fish habitat improvement - streams	miles	4	125
Fish habitat improvement - lakes	acres	0	145
Wildlife habitat management - waterfowl habitat development, shallow water impoundments, potholes	acres	20	410
Wildlife habitat management - establish forage plants and release wildlife food plants	acres	15,535	72,450
Wildlife habitat restoration and development - protect key areas by fencing	miles	50	1,255
Trail construction and improvement	miles	435	0
Road construction and improvement	miles	1,585	0
Roadside observation sites	each	140	7
Develop and control road sites	acres	360	540
Road, trail, and stock driveway bridges	each	7	60
Erosion control:			
Gullies	miles	10	165
Sheet erosion	acres	7,600	12,750
Abandoned roads and trails	miles	40	250
Streambank stabilization	miles	20	100
Mine restoration, control mining activities	miles	50	425
Water pollution abatement	acres	25	70
Snowpack management	miles	0	30

Sources: Developed by U. S. Forest Service from Project Work Inventory data.

Aspen cutover stand, Taylor Mesa,
San Juan National Forest

Forks Campground near Stoner, San Juan National Forest

Opportunities for development of range resources include: revegetation, plant control, and type conversion of 39,910 acres; 200 miles of range fence to protect critical areas and revegetated sites; 45 miles of stock distribution trails; and 215 stock water developments (Table 64). These additional developments could result in a 50 percent increase in total grazing capacity. This would be full potential for grazing on the national forest rangelands.

Recreation development planned under current programs is sufficient to meet projected demands. Although the planned development will not completely utilize the full potential, accelerated recreation development is apparently not needed at this time.

Opportunities for development of wildlife and fish habitat are numerous. Measures which could be installed to reach the physical potential are: 125 miles of stream habitat improvement; 145 acres of lake habitat improvement; 410 acres of waterfowl habitat, shallow water impoundment, and pothole development; planting and release of wildlife food plants on 72,450 acres; and 1,255 miles of fencing to restore habitat and protect key wildlife areas (Table 64). The streambank stabilization, pollution abatement, and erosion control features of the water resource development program will have an extremely beneficial effect on fisheries.

State and Private Forest Land Programs

There are also many opportunities to develop projects on the basin's state and privately owned forest lands. There is about 5,000 acres of forest land within the project areas of the identified potential PL 566 watersheds and this program offers some opportunities for forest land development. Existing cooperative programs can be expanded and, with these, there are good possibilities for state and private forestry projects.

Water resource projects include PL 566 assistance on 5,000 acres, reforestation of 6,000 acres of bare and poorly stocked areas to halt sheet erosion, sediment production, and improve hydrologic conditions. Improved fire protection is also a possiblity on the 596,000 acres of state and private forest land (Table 65).

Achieving the full potential for timber production requires that state and private forest lands contribute their share of timber. Project opportunities are intensive management surveys on 33,000 acres; extensive surveys of 75,000 acres; thinning, release, and pruning on 46,000 acres; and insect and disease control on 3,000 trees (Table 65).

The 6,000 acres of tree planting in the water resource program may eventually add to the timber supply, but this will be secondary to the watershed uses.

Economic development possibilities include rural area development assistance on 50 acres, and 20 marketing and utilization studies.

Table 65.--Estimated opportunities for land treatment and accelerated development on state and private forest lands, Dolores River Basin, Colorado and Utah.

Item	Unit	Amount
Timber stand improvement - thinning, release and pruning	acres	46,000
Timber surveys - extensive	acres	75,000
Timber surveys - intensive	acres	33,000
Tree planting and seeding - reforestation of watersheds and windbreaks	acres	6,000
Insect and disease control	number trees	3,000
Fire prevention and control	acres	596,000
PL 566 watershed assistance	acres	5,000
Rural area development assistance	acres	50
Marketing and utilization studies	number	20

Source: State Foresters' land treatment needs inventory.

Farmers Home Administration Projects

Farmers Home Administration has two projects that will be in by 1980 and are considered in the early action program. The FHA has approved an insured loan for $262,000 to the town of Naturita to improve and expand the town's domestic water system. Work includes installation of 30,000 feet of distribution and service lines, construction of a 500,000 gallon storage reservoir, and a water treatment plant.

Another FHA assisted project is the Stoner Ski Course at Stoner. Improvements discussed in Chapter VII were completed in 1968. Another loan has been approved for the Sky Hi Ski Club to move and remodel their warming hut. Work will include construction of a ski shop, sun porch, storage rooms, refreshment stand, and space for the ski patrol.

Beneficial and Adverse Effects

Potential PL-566 Projects

The beneficial and adverse effects of the potential PL-566 projects are displayed against the multiple objective planning accounts as described in the Water Resources Council's, "Proposed Principles and Standards for Planning Water and Related Land Resources." 1/ The effects are displayed for the National Economic Development, Regional Development, Environmental Quality and Social Factors objectives. The effects are as follows:

Table 66.--Summary of a Plan

Objective/Account	Recommended Plan
National Economic Development	
Beneficial effects:	
A. The value to users of increased outputs of goods and services, e.g., flood control, power, water supply, irrigation, and recreation.	
Total beneficial effects	$408,200
Adverse effects:	
A. The value of resources required for a plan, e.g., project construction and OM&R and project pumping power.	
Total adverse effects	$329,300
Net beneficial effects	$ 78,900

1/ Federal Register, Vol. 36, No. 245, Dec. 21, 1971.

Table 66.--Summary of a Plan (contd)

Objective/Account	Recommended Plan
Environmental Quality Components	
Beneficial and Adverse Effects:	
A. Open and green space, lakes, shores, mountains, and other areas of natural beauty.	1. One reservoir (Buckeye) would be enlarged from 1,600 acre-feet to 4,217 acre-feet, of which 633 acre-feet would be permanent storage. This would provide a permanent pool area of 54 acres plus a temporary pool area of 132 acres. (The present temporary pool area is 112 acres.) 2. Inundate an additional 74 acres of land now used for livestock and wildlife grazing. 3. Vegetative disturbance would occur on 22 acres during construction of two floodwater retarding structures. All but one acre would be revegetated.
B. Archeological, historical, biological, and geological resources and selected ecological systems.	1. Inundate 74 acres of wildlife habitat for deer and elk. 2. Enhance early season habitat for ducks by 74 acres. 3. Two acres of cover for wildlife destroyed due to irrigation ditch construction.
C. The quality of water, land and air resources.	1. Late season use of irrigation water would permit spring and early summer recreational use on full reservoir. Late season drawdown of the reservoir will result in exposed shoreline, thus detracting from aesthetic, recreation and habitat quality for fish and waterfowl. 2. Reduction of floodwater and sediment damage to 120 acres of urban area in Dolores. 3. Improved health standards through reduction of dust problems caused by flood carried sediment.
D. Irreversible commitments of resources to future uses.	1. 74 additional acres would be allocated to water storage.

Table 66.--Summary of a Plan (Contd)

Objective/Account	Recommended Plan	
	Regional Development Components	
	Project Area	Rest of Nation
Beneficial effects:		
A. The value of increased outputs of goods and services from a plan to the users residing in the region under consideration, e.g., flood control, power, water supply, irrigation and recreation.		
Total beneficial effects.....	$457,200	-$ 49,000
Adverse effects:		
A. The value of resources contributed from within the region under consideration to achieve the outputs of a plan, e.g., lands, easements, rights-of-way, general taxes.		
Total adverse effects.....	$253,100	$ 76,200
Net beneficial effects.....	$204,100	-$125,200
	Social Factors Components	
Beneficial and adverse effects:		
A. Real income distribution	1. Create 34 low to medium income permanent jobs for unskilled and semi-skilled workers.	
B. Life, health and safety	1. Provision of 100-year flood protection to Dolores.	

Forest Resource Programs

Reforestation and afforestation

Beneficial effects:

Erosion, sediment production and stream turbidity will be reduced.
Downstream flood plains will have smaller depositions of sterile sediment.
Forest cover will improve aesthetic values of depleted and eroding open areas.
Hydrologic improvement of forest floor will reduce flood peaks of local rainstorms.
Air quality may be improved by increased photo synthetic energy fixation and carbon storage.
Timber supplies will be increased.

Adverse effects:

Establishment of tree cover may reduce grazing capacity and area of wildlife food supplies.
Tree species available for planting will be unpalatable to wildlife, thus reducing habitat quantity.
Large areas of single species planting may degrade aesthetic environment by loss of variety in landscape form, texture and color.

Release, Weeding, Thinning, and Pruning

Beneficial effects:

Improved stand vigor and higher litter production may improve soil stability and water quality.
Opening stands to sunlight induces growth of low vegetation beneficial to wildlife.
Debris and litter left on ground absorbs raindrop impact, thus reducing soil movement and increasing infiltration.
Air quality may be improved by increased photosynthesis in more vigorous stands.
Organic content of soil will be increased, soil biota will multiply, and improved tilth, fertility and aeration of soil will result.
Timber supplies will be increased.

Adverse effects:

Short-term increased fire hazard will be present.
Herbicides, if used, may affect off-site vegetation and fauna.
Changes in stand composition and age may change quality and amount of wildlife habitat.
Removal of large, rough trees will degrade aesthetic values by reducing variety and interest.
Aesthetic values may be degraded by large areas of trees with similar ages, color, and size.
Susceptibility to catastrophic insect and disease loss is increased by limiting species variety.
Increased logging may result in erosion and watershed degradation.

Insect and Disease Control

Beneficial effects:

Tree mortality and degradation losses are reduced.
Increases in potential timber supplies may reduce area which needs to be logged to satisfy demands.
Fire hazard will be reduced.

Adverse effects:

Chemicals, if used, may pollute soil and water.
Prey-predator relations may be upset.

Road Construction and Improvement

Beneficial effects:

Improved access can result in faster, more efficient treatment of fire, insect and disease outbreaks and may reduce losses.
Decadent old growth stands may be efficiently harvested or managed, and more vigourous stands established. Wildlife habitat may be improved and water yields may be increased.
Human enjoyment of scenic landscape may be expanded by improved access.
Hunting and fishing demands may be more equally distributed.

Forest Resource Programs (contd)

Adverse effects:

Erosion and sediment production may be increased with a detrimental effect to water quality.
Expanded human encroachment may result in pollution of water and air and degradation of aesthetic landscape values.
Several thousand acres of forest and/or range land occupied by the road sites will be removed from production, and dynamic productivity and climatic influences of these areas will be lost.

Range Revegetation, Plant Control, Type Conversion

Beneficial effects:

Revegetation of bare areas will reduce erosion and sediment production.
Stream quality may be improved.
Hydrologic characteristic of rangelands will be improved.
Grazing use will be more equally distributed and overused areas may be restored.
Some types of wildlife habitat; e.g., upland game birds, may be enlarged and improved.
Water yield may be increased where brush is replaced by grasses.
Noxious or poisonous plants harmful to man, wildlife, and domestic animals will be reduced or eliminated.
Air quality may be improved by increased photosynthesis on well vegetated rangeland; wind erosion and dust may be reduced.

Adverse effects:

Chemicals such as fertilizers and herbicides, if used, may enter and degrade the soil and streams.
Areas of native forbs and shrubs useful to wildlife, especially gambel oak, will be reduced.
Fire hazard may be increased on shrub and brush areas.
Aesthetic quality, especially variety of land form and texture, may be degraded.
Physical damage to soils may result from heavy machinery used in "chaining" for type conversion.

Range Management - Fencing, Stock Trails, and Water Development

Beneficial effects:

Damage from overgrazing will be reduced.
Soil stability may be improved, erosion and sediment production reduced.
Grazing use will be more equally distributed and streamside damage will be reduced.
Organic wastes, bacteria, and other pollutants entering streams may be reduced.
Wildlife habitat may be enhanced.

Adverse effects:

Erosion may be accelerated on stock trails.
Soil compaction on trails will degrade hydrologic properties.
Wildlife habitat area may be reduced.
About 500 water developments ranging from one-tenth (0.1) to one-half (0.5)-acre in size will reduce area of rangeland by 50 to 250 acres.

Erosion Control and Hydrologic Improvement

Beneficial effects:

Sediment production will be decreased, streams will be less turbid, off-site damages will be reduced.
Peak flood flows and overland flow from rainstorms will be reduced.
The delivery period of snow melt and rainfall runoff will be lengthened.
Aesthetic qualities will be improved as gullies and bare soil are covered by vegetation.

Adverse effects:

Chemicals such as fertilizers may enter and degrade streams.
Total water yield may be reduced by evapotranspiration on treated sites.

Wildlife Habitat Improvement - Aquatic

Beneficial effects:

Populations of high value species; e.g. trout may expand.
Aesthetics will be improved.
Turbidity will be reduced by bank stabilization.
Dissolved oxygen in streams may be increased by riffles and aerating structures.

Adverse effects:

None.

Wildlife Habitat Improvement - Terrestrial

Beneficial effects:

Carrying capacity for desirable wildlife species will be increased.
Establishment of low growing (understory) plants will reduce raindrop impact, improve infiltration and reduce erosion.
Openings in forest stands will improve landforms, textural and color components of aesthetic environment.

Adverse effects:

Domestic grazing capacity may be reduced.
Parasites and disease epidemics may be more severe and frequent if concentrations of wildlife result.
Increases in total wildlife populations may result in increased soil and water pollution from organic wastes, bacteria, and viruses.
Practices which favor one group of wildlife species may militate against others and result in decline of some species, e.g., large herbivores vs. upland game birds and small mammals.

Added and Improved Forest Fire Protection

Beneficial effects:

Protection of vegetation and soil will improve soil stability and reduce sediment production.
Animal life (biota) of forest and range communities are protected from catastrophic losses.
Helps maintain scenic quality of forest and range lands.
Controls a source of air pollution.

Forest Resources Programs (contd)

Adverse effects:

Control of wildfire in ecosystems developed under historical fire regime may result in gradual conversion of a forest type.
Some loss in long distance landscape values such as texture, color, and variety of form may occur.
Certain wildlife habitats may suffer from exclusion of fire.
Essential nutrients may be "locked up" in organic forms for long periods of time.

Preservation of Unique Areas, Wilderness, and Primitive Areas

Beneficial effects:

Preserves areas that cannot be duplicated (in face of competing uses for land).
Provides for scientific study of relatively undistrubed environments.
Aesthetic values of spectacular and/or undisturbed areas are maintained.
Low erosion rates and high water quality are maintained.

Adverse effects:

Some restriction in the range of uses.
Some benefits and material output of multiple-use sustained yield management are lost.

Dolores Watershed

Effects on forest environments:

None. All structural proposals are on nonforest sites.

Gurley Watershed

Effects on forest environments:

The most feasible project is apparently enlargement of Gurley Reservoir, which would not affect forest lands, and the concrete chute on Beaver Intake Canal. The Beaver Creek Intake Canal would involve forest land, but the amount needed for the enlargement is not specified. Some forested land would be replaced by cleared access road, and the existing channel would be permanently widened with additional loss of forest area.

Tabeguache Watershed

Effects on forest environments:

None.

West Paradox Watershed

Effects on forest environments:

70 acres of forest land will be affected by the enlargement of the reservoir.
Recreation developments will affect about 25 acres of forest land.
Land treatment proposals will affect about 9,700 acres of forested land.

Impacts on forest environments:

Enlargement of lake environment by 70 acres.
Removal of 70 acres of coniferous forest to accomodate the enlargement.
Alteration of natural forest conditions on 25 acres for recreation facility installation.
Alteration of streamflow and ground water regime in vicinity of reservoir.
Removal of vegetation, temporary exposure of soil, and increased sediment production during construction. About 10 to 15 acres of dam structure site, access road, and borrow areas will be damaged.
Increased public use (estimated 5,000 visitor days annually) around enlarged lake with probability of increased pollution of water.
Intensification of forest influences on 9,700 acres through application of forest land treatment measures. Impacts are evaluated in the previous section covering forest land programs.

Projects of the U.S. Bureau of Reclamation, State of Colorado, and private developers may affect forest environments but are beyond the scope of this report. Environmental and economic impacts of these projects will be evaluated individually when proposals are formally presented for USDA review.

Physical and Biological Effects

There is an estimated potential for increased production of approximately 20 percent on the irrigated lands with the use of a combination of drainage practices which allow for leaching and removal of soil profile water accumulations. Elimination of seepage damage goes along with the drainage improvement program.

Water quality changes in terms of total dissolved solids would be minor. Increased reservoirs storage would have the effect of slightly increasing total dissolved solids, but since the water to be stored is of good quality the increase would only relate to the amount of water evaporated. In terms of suspended sediment the Gurley and Tabeguache potential projects will be of benefit to the irrigation and municipal water users in that many of the eroding canals will either be eliminated or lined. Benefits will be reduced expenditures for sediment removal in the irrigation system and better water for the Norwood municipal water treatment facility to process.

The going programs of the USDA provide for land treatment measures on water-yielding lands of the U. S. Forest Service, and protection from fire through cooperative fire prevention and control programs of the Forest Service, Bureau of Land Management, Colorado and Utah State Foresters, and the local counties. The Soil Conservation Service-Soil Conservation District soil and water conservation programs consider all aspects relating to crop and rangeland resources. The impacts include improved vegetation for range livestock use, enhancement of municipal and industrial water supplies, augmentation of fish and wildlife resources, creation of additional recreation areas, improved irrigation efficiencies, and a more stable agricultural base.

Economic Effects

The beneficial and adverse economic effects of the four potential projects are displayed in Table 66. The net beneficial effects on national economic development resulting from project operation amounts to $78,900. On regional development, the net beneficial effects are $202,200 with the associated rest of the nation component showing a negative net beneficial effect of $125,200.

The beneficial effects on the social factors of the region would include the development of 34 new, low-to-medium income permanent jobs.

Erosion and sediment production caused by man's use of the land can be reduced over 50 percent with land treatment practices and management. By reducing sediment, the storage displacement by sediment in reservoirs can also be reduced. Monetarily, there is a savings in storage costs of about $100 to $400 per acre-foot.

Annual projected increase in livestock and feed production from land treatment practices on state and private land is expected to amount to $148,530 by 1980 (Table 63).

Recreational Opportunities and Benefits

In addition to the preceding impacts, recreational benefits will accrue when the West Paradox Watershed Project is constructed. It is estimated that over the evaluation period 5,000 average annual visitor-days will be attributable to the project. Recreation benefits are estimated to be $5,000 annually.

Water Supply Services

Farmers Home Administration project for the town of Naturita will serve 274 family dwellings, 38 commercial firms, 1 school, and 4 churches. Construction of the project will provide 4,000 man-days of employment for engineers, well drillers, equipment operators and workmen and construction should be underway by the early 1970's.

X. COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Alternative Approaches

Productive use and future development of the physical, biological, social, and economic resources of the basin are important responsibilities of local people. Wise and careful management can enhance and perpetuate the quality and usefulness of the environment, but many efforts including research, education, and land use planning are needed. There are many federal, state, community, and private programs available, that are applicable to specific segments of conservation planning and implementation. In many instances there is duplication of effort, overlapping of purpose and scope, and agency rivalry in the application of these programs. Alternative levels of development exist not only in the physical and economic potentials but also in the choice of programs that will best solve the problems and satisfy the needs. To more effectively extend the services of available federal and state agency programs, USDA Committees for Rural Development have been formed. These committees assist rural communities groups, and individuals locate and secure the needed service programs. Evaluation of alternative programs, when a choice is available, is up to the local people.

Not all the potential development discussed in Chapter VIII is feasible or applicable under going USDA programs. However, there is a need to coordinate all programs into an overall plan of development. For example, the Department of Interior's multiple purpose San Miguel Project (Chapter VII) will develop reservoir storage for agricultural, municipal, industrial, and recreational uses. As a direct result of this water development there will be many opportunities for agricultural and recreational development under the Department of Agriculture's programs. Maximum benefit of this development can be realized by cooperating with the Department of Interior in coordinated planning.

Other Agency Programs and Their Impacts

Bureau of Reclamation

Over 26,000 acres of new land will be developed by the bureau's San Miguel Project; in addition 12,000 acres will receive supplemental water. The new land is expected to provide 50 family-size farm units that will require all phases of agricultural preparation and management prior to successful irrigated farming. Other project benefits will include approximately 44,000 acre-feet of water for municipal and industrial purposes and 500 acre-feet of water for exclusive use by fish and

wildlife. The direct effect of the San Miguel Project on fish and wildlife values has been estimated at $204,000 annually by the U. S. Bureau of Sports Fisheries and Wildlife.

Recreation benefits from both the San Miguel and Dolores Projects will provide important returns to the basin. The bureau's projects will add over 12,000 surface acres of water area that will contribute to the enhancement of recreational opportunities. Additional income to local area residents will also be realized through commercialization and development of related recreational enterprises.

Colorado Division of Game, Fish and Parks [1/]

The division will continue to develop and maintain facilities and programs to provide recreation benefits utilizing resources of the basin. Cooperative planning on all phases of the division's program is a continuing phase of project development. Benefits from two proposed projects will be increased because of joint sponsorship: (1) Gurley Reservoir Enlargement - The Colorado Division of Game, Fish and Parks and the U. S. Fish and Wildlife Service are cooperating with the Bureau of Reclamation and private concerns to increase recreational benefits at Gurley Reservoir. The desire is to improve fish harvest by increasing the size of the minimum pool. Cost differential, to raise the reservoir an additional four feet over the level needed for agricultural uses, would be paid by the Game, Fish and Parks Division. A minimum pool of 1,683 acre-feet would have a surface area of 154.5 acres, an increase of about 3.4 times the existing area. The number of fish could be increased by at least a like amount. (2) USBR San Miguel Project - Cooperative studies involving the U. S. Fish and Wildlife Service and the Colorado Division of Game, Fish and Parks indicate that over 25,000 acres of wildlife area (primarily winter deer range) would be lost through conversion of rangeland to cropland and inundation at reservoir sites. The mitigation of these losses has stimulated a growing concern among interested agencies and private groups. One solution is to create a big game management unit in Dry Creek Basin to help compensate for big-game losses. A land acquisition program to acquire 12,850 acres is proposed. Management of this area would include: (1) range improvement and rehabilitation, (2) supplemental planting of shrubs for winter forage, and (3) cultivation of irrigated land for supplemental forage supplies. These activities would reduce the expected wildlife depredation on developed cropland and would replace about 75 percent of the losses induced by the bureau project.

[1/] Now, the Colorado Division of Wildlife and Colorado Division of Parks and Outdoor Recreation.

Federal Water Quality Administration [2/]

The Federal Water Pollution Control Act was enacted by Congress in 1956 and was last amended in 1966. One of the features of this act authorized the federal government to make grants to municipalities to help finance construction of sewage treatment works. This program is a cooperative effort by federal, state, and local interests to help curb the pollution problems.

Grants are limited to 30 percent of the eligible cost, except that a grant may be increased to 40 percent in states which agree to pay not less than 30 percent of the estimated reasonable cost of all projects for which federal grants are to be made from the states' allocations. The federal grant may be increased to 50 percent if a state agrees to pay not less than 25 percent of all projects and enforceable water quality standards have been established for the water into which the project discharges. A grant may be increased by ten percent, to 33, 44, or 55 percent, as appropriate, if the project is certified by a metropolitan or regional planning agency as conforming with a comprehensive metropolitan area plan. Any municipality that has authority to construct, maintain, and operate a sewage treatment facility, may be eligible for grant consideration. A municipality is defined as any city, town, borough, county, parish, district, or other public body having jurisdiction over sewage and waste disposal. Indian tribes or authorized Indian tribal organizations are included.

Construction costs eligible for Federal Water Quality Administration (FWQA) grants are: (1) new sewage treatment works or additions, extensions, alterations, acquisitions, and improvements of existing works, (2) providing interception sewers, outfall sewers, pumping, power, and other equipment, and (3) preliminary planning, engineering, legal and fiscal investigations, studies and designs, and construction inspection.

Work completed in the basin under FWQA grants include: (1) Telluride - construction of interceptor lines and waste stabilization pond, $75,000 construction cost, completed in 1968, (2) Nucla - waste stabilization lagoon, $13,500 construction cost, completed in 1960, and (3) Naturita - mechanical waste treatment system, $48,000 construction cost, completed in 1957. Naturita also has a potential enlargement project for consideration under an FWQA grant for a secondary treatment facility.

Another FWQA program is a radiological surveillance system that monitors the Dolores and San Miguel Rivers for water contamination. Monitoring stations at Uravan, Naturita, Bedrock, and Gateway are read as often as three times a week. High readings of greater than acceptable contamination have caused processing modifications at the Uravan mill. A new recirculation process and additional waste ponds were used to bring the plant effluent into acceptable state standards.

[2/] Now, the Environmental Protection Agency.

Cooperation of municipal areas and mining interests in the basin have made it possible to maintain the quality of water leaving the basin.

Four Corners Regional Commission

This program was established to enable the states and communities in the development region to take maximum advantage of applicable federal grant-in-aid programs for which they are eligible, but because of economic situations, cannot supply matching funds. Supplemental grants may be used to increase, to a maximum of 80 percent, the federal share of projects selected for assistance under certain going aid programs. For example, if the maximum federal share of an authorized PL 566 project amounts to 60 percent, a supplemental grant from the Four Corners Regional Commission (FCRC) may pick up an additional 20 percent leaving only 20 percent as local cost. Program priorities are established by the FCRC and are intended to achieve the greatest development effect from limited funds.

The FCRC in cooperation with county, regional, and other agencies interested in Four-Corners development, has prepared a framework plan for program action. This plan known as the Rural Areas Development Framework Plan contains the objectives and other data related to the FCRC program. Basic federal programs that may be supplemented include: (1) community development, (2) education, (3) health, (4) land resources and recreation, (5) transportation, and (6) water resources and pollution.

The Dolores River Basin has several potential project opportunities that could be eligible for FCRC grants. The agricultural water management and irrigation system rehabilitation watershed projects (Gurley, Tabeguache, and Paradox) discussed in Chapter IX, may be eligible for grant-in-aid assistance. Other opportunities such as hospital, transportation facilities, and municipal sewer and water needs may also receive FCRC grants.

New Programs

Legislation is needed to provide technical assistance and conservation treatment application to areas being scarred and disfigured by mining activities. Strip coal mining operations, as well as smaller uranium-vanadium mills and mines, have left some unsightly areas of disturbed soil and waste materials. Besides being unsightly, these steep and poorly vegetated areas of spoil materials and overburden will contribute to stream pollution during intense rainfall periods. Some federal agency, in cooperation with the states, should have the authority to see that rehabilitation of the mined over areas is carried out. Restoration should include leveling off of piled up overburden and reestablishment of a locally adaptable vegetative cover. Legislation could establish standards of compliance for all areas with these kind of problems.

Other new programs and alternative methods also should be considered for further basin development. Existing authorities should be modified to place more emphasis on the following: (1) establishment of a cooperative marketing system for farmers and ranchers that would help reduce the high cost of freight transportation and related expenses, (2) establishment of training facilities to retrain unskilled labor for out-of-agriculture employment, (3) promotion of industry and business that would provide additional off-farm employment, and (4) exploration of all possibilities for new farm enterprises.

Future development in the Dolores Basin should be controlled through new zoning laws that will insure orderly growth and resource conservation. County and municipal planning commissions should establish zoning boards that can cope with future expansion and deal with problems such as: (1) home-site location and urban developments, (2) locations for industrial expansion, (3) routing of new highways, airport locations, and other transportation facilities, (4) agricultural land preservation and bottom-land flood hazard zoning restrictions, (5) preservation of natural environment, (6) municipal water and sewage disposal site locations, and (7) location of refuse disposal areas.

All USDA field agencies are available and will cooperate with other federal, state, and local agencies in the development of land and water projects proposed for the basin.

Potential Utilization of Water Resources Outside the Basin

The Dolores River Basin has had an abundant water supply; the amount of water exported has exceeded the man-related consumptive use in the basin. The average export during the 1943-60 period was 115,700 acre-feet compared to the consumptive use in the basin of 56,700 acre-feet. By 2020 the export is estimated to be 289,900 acre-feet compared to the consumptive use of 143,200 acre-feet.

The Dolores Project is expected to be operational by 1980 and will export 126,900 acre-feet of water to the San Juan River Basin for agricultural, municipal, and industrial use in the Cortez-Dove Creek area. Irrigation use will amount to 120,800 acre-feet divided between 32,300 acres of new land and 28,600 acres of presently irrigated land with an inadequate water supply. The remaining 6,100 acre-feet exported by the Dolores Project is for municipal and industrial purposes primarily in Cortez and Dove Creek.

The potential PL 566 project (IX-5, Project Location Map) considered as a water export, combines the features of water storage in two reservoirs on Dolores River tributaries with the existing export facility maintained by the Montezuma Valley Irrigation Company near Dolores. Eight thousand

acre-feet would be stored in each reservoir for release during the latter part of the irrigation season. The water would be diverted from the Dolores River near Dolores and would be used to supplement the water short irrigated area north of Cortez.